THE PRINCIPLES OF 'OPEN-AIR' TREATMENT OF PHTHISIS AND OF SANATORIUM CONSTRUCTION

BY
ARTHUR RANSOME, M.D.,
F.R.C.P., F.R.S.

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PREFACE

The influence of an abundance of fresh pure air in the cure of phthisis has now been recognised for many years, and instances of its successful employment have been frequently recorded. Before the introduction into this country of sanatoria for the so-called 'open-air treatment' I had noted many cases of the cure of the disease under its influence. Some of these cases are noticed in the work on 'Prognosis in Lung Disease,'[1] and again in 'The Treatment of Phthisis.'[2]

A complete demonstration of the curative power of this agent was not, however, given until Brehmer and Dettweiler systematised its employment, and combined with it the practice of full feeding, rest and exercise, water treatment, and the like.

The treatment had already been practised in most of its details, in the year 1840, by George Boddington, of Sutton Coldfield, Warwickshire, but we undoubtedly owe our thanks also to the men who

[1] Macmillan & Co. 1882, pp. 81 and 83.
[2] Smith, Elder, & Co. 1896, pp. 212 to 227.

first put the method to the test of figures, and especially to the one, Dr. Dettweiler, who wrote so convincingly of its merits.

Dr. Dettweiler, although he wrote with great caution, gave many proofs of the success of the treatment, and his results have now been more than confirmed by the reports which have issued from the many sanatoria established all over the world in consequence of his representations.

The efficacy of the method in the cure of phthisis has, therefore, now been established beyond the shadow of a doubt, but hitherto little has been attempted in the way of explaining the mode of action of the several factors of the treatment. Moreover, although many accounts of the method have been given, both by patients and by medical men, no satisfactory statement of the principles upon which the course of treatment should be pursued has yet been made.

It seemed to me desirable that a method of treatment, which has assuredly given excellent results, should be placed upon a scientific basis, and that it should be rescued from the position of empiricism into which, at the present time, it seems in some danger of falling.

In the present essays I have endeavoured to keep both of these objects in view, and have also ventured to formulate the conditions under which a model sanatorium for consumption should be constructed.

Essays I. and II. deal with the first part of the

programme, Essay III. with the principles of construction, and in Essay IV. I have pointed out certain stringent conditions under which alone the treatment can be carried out in private houses.

My cordial thanks are due to Dr. HORT, of San Remo, for the great assistance which he gave me in preparing the first part of the work, Essay I.; to Dr. ALFRED COLES, of Bournemouth, for his help in Essay II., and to Mr. G. A. BLIGH LIVESAY, F.R.I.B.A., of Bournemouth, for his kind assistance in scheming and drawing the plans for a model sanatorium, and for his advice as to its construction, contained in Essay III.

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THE PRINCIPLES OF SANATORIUM AND 'OPEN-AIR' TREATMENT OF PHTHISIS

ESSAY I

THE PRINCIPLES OF SANATORIUM AND 'OPEN-AIR TREATMENT OF PHTHISIS

1. The factors of sanatorium treatment—2. The need of sanatoria—3. The advantages of sanatoria—4. Alleged disadvantages of sanatoria—5. Modes of action of means employed: A, of pure air and sunlight; B, of full feeding; C, of rest; D, of exercise, massage, &c.; E, of baths and cleanliness; F, of blood-making; G, of comfort, warmth, amusements, of clothing; H, medical and surgical treatment; I, education and discipline; K, disposal of excreta; L, medical attendants and staff.

INTRODUCTION

BEFORE discussing the sanatorium or 'open-air' treatment of consumption, it is desirable to be convinced as to the need of sanatoria for the reception and treatment of cases of this disease.

It is necessary, therefore, (1) to enumerate the factors of systematic sanatorium treatment; (2) to say a few words as to the reasons for establishing such institutions; and (3) to state the advantages or (4) the possible disadvantages of sanatorium treatment. We can then consider in detail the means employed and their modes of action. A few words must also be said as to the general management of such an establishment.

These points will form the subject matter of the present essay, and we shall then, in the subsequent essays, be better prepared to consider the bodily conditions needed for the prevention and cure of the disease,

the constructive arrangements of a model sanatorium, and, lastly, the conditions under which the treatment may, in certain cases, be carried out in a private house.

1. FACTORS OF SANATORIUM TREATMENT.—Briefly, the sanatorium treatment of tuberculosis consists in (*a*) always surrounding the patient, without undue exposure, night and day, with the purest air obtainable and with the maximum amount of available sunshine. This involves gradual acclimatisation of the patients, always avoiding undue exposure to rain, snow, cold winds, or draughts.

(*b*) Careful and sufficient feeding: chiefly with meat foods and milk, with special attention and assistance to individual needs.

(*c*) Rest, for some patients in a recumbent posture, for the greater part of the day and night; sometimes in bed, at other times in the open grounds, in verandahs, or other shelters.

(*d*) Massage, &c., in some cases, carefully graduated exercises in others.

(*e*) The judicious use of baths and cold sponging.

(*f*) Means of blood-making.

(*g*) Suitable arrangements for warmth, lighting, general comfort, and for admissible amusements.

(*h*) Medicinal and surgical treatment, when necessary.

(*i*) The education and discipline of the patient, especially (*k*) in regard to the disposal of his excreta, but also in the use of all the aforementioned means of cure.

(*l*) Finally, and above all, constant supervision by competent medical men, practically conversant with all the *minutiæ* of the treatment, and having under them an adequate staff of trained nurses and other attendants.

Most of these conditions point to the need of special institutions for the treatment, and will be considered in their turn.

Throughout this essay it is assumed that tuberculosis is both preventable and curable. It would be easy to adduce proofs of this statement, but it is surely needless at the present day to elaborate any arguments on these points. I have, therefore, left them untouched.

2. The Need for Sanatoria.—The chief reasons for the establishment of more sanatoria for tubercular cases are (*a*) the infective character of the excreta, especially of active tuberculous sputum, (*b*) the inadequate nature of the provision now made for its treatment.

(*a*) It is now universally acknowledged that although, with proper precautions, there is no danger from personal intercourse with tubercular patients, the chief means of spreading the disease is fine atmospheric dust containing the active virulent specific bacillus. It is certain (1) that the organism, in suitable surroundings, retains its virulence for long periods of time; (2) that, if it gains an entrance into the bodies of beings who are or who have become susceptible, whether men or lower animals, it starts the disease, and (3) that this occurrence is most likely to take place in the overcrowded dirty and dark dwellings of the poor; in the ill-ventilated badly lighted habitations of all classes of society; and in most of the crowded places of public assembly. It is important therefore for their own sakes, for their education in hygiene, and for the safety of the general public, that as many as possible of these persons should be treated in sanatoria.

(*b*) It has been shown that, in the British Isles, there is proper hospital accommodation for only a very small proportion of those requiring it.

It has been calculated that, in order that every consumptive in the kingdom should have three months' treatment in a sanatorium, 38,000 beds would be required, or perhaps half this number for the poor.[1] The total accommodation now is not a twelfth part of this. Moreover, for the treatment of many thousands of children suffering from tubercular diseases of the joints, &c., a prolonged stay in some seaside place needs to be provided.

It may be remarked, incidentally, that, although we may fairly hope that phthisis will ultimately be stamped out as thoroughly as leprosy, sanatoria of the kind proposed will always be useful, seeing that the open-air treatment is now proved to be of service in many other diseases; and that they will always be of great service as convalescent homes for all kinds of cases.

3. The Advantages of Sanatorium Treatment.—The sanatorium has no monopoly of the open-air treatment.

Fortunately for the many who are unable to enter these institutions, much may be done for them elsewhere under certain rigorous conditions. But a glance at the list of the means to be employed shows the great advantages to be obtained in a sanatorium devoted to the purpose. One of them especially to be noted is the constant supervision by the medical officer, supplemented by the watchfulness and care of an efficient staff of nurses. It is also seen in—

[1] Dr. R. Walters, *Sanatoria for Consumptives.*

The careful education of the patients in the new *régime*, and the infusing into them of courage and hope.

The close study of changes in physical condition, on which to base prognosis and future treatment.

The taking of temperatures at certain regular intervals, and in the most efficient manner.

Gradual acclimatisation to the open air, together with tactful combating of prejudices and fears of 'catching cold.'

Superintendence of food, medicinal treatment, rest, exercise, ablutions, baths, and amusements.

Keeping a watchful eye for the advent of any complication, such as catarrh, hæmoptysis, pleurisy, gastric disturbance, or the least elevation of temperature. If symptoms of these disorders should occur, the doctor will deal with them at their onset, and will often prevent them from becoming serious. All these objects are better attained in a sanatorium than in a private house.

4. Alleged Disadvantages of Sanatoria.—It has been made a serious reproach to all hospitals and other establishments for phthisical persons that they are likely to become centres of infection, and that the disease will thus spread from the sick to healthy persons. This accusation has, however, been amply disproved by most of the hospitals for consumption in this country; more especially with regard to the large hospitals in London and Manchester.

It has been shown by Drs. Pollock and C. T. Williams that there has been no spreading of the disease in Brompton Hospital, and the evil is obviously still less likely to occur in the breezy open-air treatment in the country. As a fact, the most

virulent tuberculous sputum entirely loses its power of conveying the disease after comparatively short exposure to fresh air in motion and to sunlight; an exposure too short to have permitted the formation of the fine tuberculous dust in the air, which is the most potent means of contagion.

In sanatoria, with pure air freely flowing through the rooms, night and day, and with full exposure of every dormitory to the light of the sun, the possibility of this accident is minimised; and we may add that the care taken in these establishments to disinfect and destroy every particle of sputum is sufficient to make infection from the patients an impossibility.

Observations on the infective power of dust from such places have proved the correctness of this contention.

Another objection of more importance is the depressing influence of the presence of many invalids in all stages of the disease.

Against this, however, must be set the encouragement to persevere that comes from observing the improvement in other inmates. It is no small tribute to the ability of the chief medical officers of sanatoria that they succeed so often in triumphing over any grounds for depression, and in infusing a spirit of contentment and hope into their patients.

If sufficient legitimate amusement and occupation are provided, and if the patients are carefully looked after, there is little time for introspection or for the exchange of morbid sympathies.

The tendency to chatter and gossip, and to undue excitement, can usually be overcome by judicious regulations.

5. The Principles of Sanatorium Treatment

We shall next discuss the modes of action of the several factors of this treatment. It has been described by some authors as the 'hygienic' treatment of the disease. This is perhaps justified, in so far as its aim is to cultivate the bodily powers to their utmost extent and thus to enable them to resist the disease.

More than this is, however, attained. Although the exact action of each factor is not yet fully understood, still in all of them there is some special adaptation to the requirements of the phthisical patient, and together they make a direct attack upon the specific parasite.

A. The Abundance of Pure Air and Sunlight.—This is essential; but something more than the freest ventilation is the basis of genuine 'open-air' treatment. Not only must sufficient pure air be supplied to satisfy the needs of the body and to sweep ordinary impurity from the living rooms; but there must also be enough to convey plentiful supplies of ozone, and to reduce microbic life to a minimum. *Aerial sewage* must in fact be entirely got rid of. There must be no stagnant areas in corners or ceilings; and the ventilation currents must sweep away all impurity. No dusts of any kind should be allowed to float about in the air to serve as vehicles for microbic germs, or for organic refuse on which these germs may feed.

The treatment must be truly aseptic, and for this there must be 'hyper-aeration.' Actual draughts are not necessary, only a constant supply of pure air. It may be noted incidentally that there is often less sensation of draught when the windows are wide open than when they are partially closed; and, again,

it is more likely to be felt near an open window than actually outside.

It is surprising how soon patients become accustomed to the coldest air, so long as it is still; and how eagerly they seek it of their own accord. Their dread of taking cold vanishes when they learn by their own experience, and by that of others, how rarely this accident happens in pure air. After a time, indeed, positive air-hunger replaces their early repugnance, and restraint is sometimes necessary.

It has long been known that an excess of fresh air, approaching to open-air treatment, has been beneficial in all kinds of microbic disease, not only in consumption. It is therefore natural to inquire what there is in outside air that can lead to such remarkable results.

1. In the first place we must note its comparative purity. Exposure to the open air implies both more, and purer, air than is afforded by the freest ventilation. At least a hundred times the amount that is afforded in ordinary ventilation passes over the body in the open, and its scavenging work must therefore be proportionately enormous. When the air is itself fairly pure, it must sweep away every particle of organic impurity. The air of ordinary living rooms, however cleanly these may be, never contains ozone. This ingredient, if present in the outer air, is rapidly used up in oxidising the organic material contained in all confined atmospheres. This air also usually suspends a large proportion of micro-organisms. Mere cleansing of a room will often, for a time, materially increase the percentage of floating microbes. The superabundance of fresh air, then, not only cleanses the rooms, but all the clothes and wraps of the patient; hence if proper

care is taken to destroy or disinfect sputum, and to burn handkerchiefs, paper, and similar articles, there will be no tuberculous dust, no danger of re-infection of the patient himself, and no risk to others.

In such air, moreover, there will be no other pathogenic organisms.

We may with great probability ascribe the disappearance of fever from a tuberculous patient, after a short exposure to the open-air treatment, to the almost total absence of streptococci or staphylococci. The atmosphere in a well-conducted sanatorium is practically *aseptic*.

2. The air of ordinary closed-up dwelling-rooms, as we have said, never contains an appreciable quantity of ozone, whereas it is generally found in the open. It may well be, therefore, that only by open-air methods can we get the amount of active oxygen that is necessary to act medicinally on the body. I have found, indeed, that ozone can often be detected in the centres of bedrooms in a sanatorium.

Although it has been shown that ozone will not destroy bacteria, it is the natural enemy of organic impurity, and is thus a most powerful cleansing agent.

3. The air of a sanatorium must be free, as we have said, from all forms of ordinary dust or noxious vapours. There will then be nothing in it to irritate the tender lung, neither angular particles nor irritating organisms. The conspicuous absence of catarrh from all open-air sanatoria tends thus to give rest to the damaged lungs.

4. Another effect of breathing the open air is the obvious increase of red blood corpuscles in the patient. Nothing is more striking than the contrast between the

pale faces of newcomers and the ruddy complexion of old residents. This improvement in the blood has been proved by means of the hæmocytometer and hæmoglobinometer.

5. The increased power of assimilating food may also be probably ascribed to the influence of the fresh air; and (6) there is in consequence a greater degree of bodily resistance to the invasion of the microbe.

7. It is probable that the more thorough oxygenation of the blood tends to destroy, or to limit, the production of toxins by the bacillus; and hence there is less danger of fever, of tubercular pleurisy, or of pneumonia and other complications. Given intelligent nursing, the presence of even extreme pyrexia is no bar to the full treatment.

8. We may also reckon upon the starvation of the microbe, seeing that it is deprived of its favourite pabulum, the organic respiratory impurity of the air.

9. We may trace the influence of fresh air in its bracing effect upon the whole nervous system of the patient. Whether this influence is direct upon the nerves of sensation in the skin, or indirect through the better nutrition of the body, or possibly from its psychical effect, its existence is obvious to any one who has watched the course of cure in a consumptive patient.

10. *Action of sunlight.*—Under the head of pure air we must not forget the beneficial influence of sunlight, which is much more intense in the open than in rooms, or than when it has to penetrate through glass.

There is no doubt that sunshine purifies the atmosphere by its bactericidal action, especially on tuberculous material. It has further been proved that sunshine assists in combating tubercular disease. The

warmth and light of the sun quicken all vital processes, and probably increase phagocytic action. The disinfecting power of sunlight has already (page 6) been alluded to, and so great is its value in this respect that in a model sanatorium every part of every room frequented by the patients should be swept by every available ray of sunshine.

B. DIET AND FULL FEEDING.—Another part of the sanatorium treatment not yet fully understood is the feeding of the patient largely with animal food, &c. The methods of its administration are still the subject of much controversy.

It is indeed admitted by all that feeding, to the fullest extent of the patient's capacity, is an important adjunct of the open-air treatment. The increased power of taking in, and of assimilating food, which is gained by exposure to the open air, is undoubtedly one of the great merits of this treatment.

The cramming system was first introduced by Dr. Debove with some success. He employed the forcible introduction into the stomach of semi-fluid meat foods, after the manner of 'gavage,' used in the rapid fattening of fowls. By others, the prescription of three heavy meat meals per diem was carried out by the dominant will of an attendant physician ; and, on pain of expulsion from the institution, patients were made to take into their stomachs such food as was put upon their plates, even at the risk of vomiting, and after the actual occurrence of that event.

The existence of high temperatures was not allowed to interfere with the compulsory eating of heavy meals of coarse foods, such as pork chops or German sausages.

This course is hardly in accordance with ordinary hygienic rules; and yet, in many cases, it results in a rapid increase of body weight. In others, as might be expected, it caused symptoms of indigestion, and even in some instances of acute gastritis; and after-histories of some of the best examples of cures turned out by this or that sanatorium, conducted on this system, frequently show dilated stomachs or even damaged kidneys.

Its success in certain cases, however, makes it necessary to inquire (1) whether the dyspepsia of some consumptives may not be to a large extent due to nervous influence; (2) whether there may not be some antitoxic power in an excessive diet of this nature.[1] (3) We may ask whether the plethora of venous blood, produced by a meat diet, may not have a direct influence both in preventing reinfection and in keeping the blood free from septic organisms. This last question is more fully dealt with in the essay which follows: 'On certain Bodily Conditions resisting Phthisis.'

(1) The condition of the nervous system in phthisis is still not well understood. We know that its subjects are very prone to neuralgias, myalgias, &c., and Dr. Peter has described a special neuralgia of the pneumogastric and phrenic nerves. The vomiting which is so common in some cases is undoubtedly

[1] From a paper by Dr. L. Robinson, of Paris, published in the *Practitioner* for July 1901, I learn that Drs. Richet and Héricourt have made a number of experiments, from which it appears that 'raw meat, or the juice expressed from it, acts by the antitoxic agents therein contained, elements which effectively combat the tubercular intoxication,' but, so far, they have not yet decided whether the muscle plasma is 'an antitoxin, whether it stimulates phagocytosis, or if it is only a special tonic of the nervous system which has the care of organising the defences of the organism.' In any case, it is strongly recommended in the treatment of tuberculosis.

sometimes 'hysterical' in its nature, and we may readily understand that the dominant will of a skilful sanatorium physician might work wonders in such patients.

(2) There can be no doubt that, under certain circumstances, toxins produced by the bacillus of tubercle do circulate in the blood, and produce inflammations in parts distant from the original focus. Short of this also, it is probable that tissues affected by this intoxication are incapable of properly assimilating food. If the case is treated as it usually is in sanatoria, the toxin production, as evidenced by the sputum and physical signs, diminishes, and a rapid increase of weight takes place. It is then possible that, as a result of proper dieting, 'anti-bodies' are produced which react upon the bacilli and their toxins.

Another advantage of a meat diet is the increase of hæmoglobin in the blood. This must facilitate gaseous interchange, and thus lessen the work of both heart and lungs, and assist in giving 'physiological rest.'

Again, 'the special advantage of a meat diet is that, besides containing the nuclear bodies which have a directly stimulant action, it contains also proteids which have a high nutrient value. Sufficient fat and carbohydrate must be given to meet the physiological needs, and must be increased later, as metabolism and absorption improve, to the maximum which can be elaborated' (Galbraith).

The diet in sanatorium treatment has, therefore, a direct curative influence, and Dettweiler spoke even more truly than he knew when he said: '*Ma cuisine, c'est ma pharmacie.*'

If the diet can be borne, and if the fattening of the

patient lessens his fever and gives him more power of resisting the advance of the microbe into the system, and if the plethora produced is not too great, then there can be little doubt that the system of feeding is suited to the case. But we must beware of a mere mechanical adherence to fixed rules; our aim, on the contrary, should be true physiological feeding. We must take into account individual peculiarities; and we must, by careful study of each individual case, determine the patient's capacity for assimilation, and be ready to take advantage of any other means, such as nutritive enemata, of attaining our true objects, which are, briefly, an improvement in the condition of the blood and a gain of muscular and nerve power.

An important work has just been done by Messrs. Bardswell, Goodbody, and Chapman for the Scientific Grant Committee of the British Medical Association 'on the effects of forced feeding in cases of pulmonary tuberculosis, and in normal individuals.'[1] They conclude by saying: (1) 'That since very large diets gave worse results than those of more moderate amount, the indiscriminate stuffing of all tuberculous patients should be replaced by systematic dieting . . . taking into account (*a*) the activity and extent of disease; (*b*) amount below weight; (*c*) digestive capability; and (*d*) to some extent personal dietetic likes and dislikes. (2) That, in view of the bad effects which overfeeding gave rise to in normal individuals, great care should be taken in the selection of a diet for patients who, as the result of treatment, should have reached or passed their highest known weights. When the regain of weight is associated with arrested disease, the

[1] *Brit. Med. Jour.*, February 22, 1902.

original diet, found suitable for a person very considerably under weight and with active lesions, should be reconstructed more upon the lines of what would be suitable for the same person in perfect health.' These results must be pondered by every medical director of a sanatorium, and it is to be hoped that the experiments will be repeated. In the meantime the excellence of the results obtained under the dietary of the Brompton Hospital must make that dietary the model for similar institutions.

Much must necessarily be left to the judgment and experience of an intelligent medical superintendent; but, in any case, the arrangement of a perfect sanatorium must be such that good cookery and the appetising serving of meals are fully provided for. The kitchens must be in a convenient situation; they must have an efficient staff; separate feeding must be possible for such patients as require it; and the requisite apparatus for serving the meals in a hot state must be carefully provided.

c. The Influence of Rest.—This influence is manifold.

1. *Gain in weight.*—The first and, in many respects, the most hopeful result of repose is increase in the weight of the body. Given good appetite, fairly efficient digestion, and appropriate diet, there is almost certain to be some addition to the textures of the body, and especially to its fatty matter, if rest in the recumbent posture is taken before, and also immediately after, meals. In some sanatoria, rest in the open air is enjoined only for the hour before meals, but it should also be taken during the period of digestion for at least half an hour. When the body is

partially horizontal there are fewer demands upon the blood stream by *other* organs, especially by the muscles; and thus the enormous quantities of fluid demanded for the digestive juices are more easily spared. It is probable that absorption and assimilation are also carried on more rapidly during repose. In any case it is certain that in most places where the 'Liegekur' is combined with the 'Luftkur' there is a distinct gain in the body weights of the patients. This circumstance is of no small importance; it conduces to ultimate cure, encouraging patients when they need all the good spirits they can command. It is also not without reason that such patients look upon the increase of weight as a good sign. As Dr. Weir Mitchell remarks:

'Almost any grave change for the worse in health is at once betrayed in most people by loss of fat.' And again: 'The loss of fat, especially its rapid or steady loss, nearly always goes along with conditions which impoverish the blood; and, on the other hand, the gain in weight, up to a certain point, seems to go hand in hand with a rise in all other essentials of health, and notably with an improvement in the colour and amount of red corpuscles.' Of course there are exceptions to this in phthisis.

2. This leads us naturally to the second benefit conferred upon the body by repose, namely, the better quality of the blood and its more ready oxygenation. Most practising physicians have seen cases of anæmia or chlorosis which would not improve, in spite of any number of Blaud's pills, until rest in bed was prescribed, after which strength and colour were rapidly regained. It has been shown, first, I believe, by

Moleschott, and afterwards by Pettenkofer and Voit, that absorption of oxygen mostly takes place during repose; and, though there is no leucocytosis in phthisis, there is usually a great deficiency of hæmoglobin. One of the results of rest combined with fresh air is a speedy improvement in the complexion of our patients.

3. Robin and Binet have recently shown that, among two or three other agencies, 'rest' retards tissue change and puts the body into exactly the opposite condition to that which is most favourable to the growth of the tubercle bacillus.

4. The continuous warmth of the body, during exposure to open air, is better kept up in the recumbent posture than in any other. Cold is felt much more acutely sitting than lying down, the feet and the knees cooling much more rapidly in the former posture. It is certain that the circulation in the lower extremities is better carried on when the blood comes in a straight line direct from the heart to the toes, when it has not to overcome the resistance offered by the two right angles formed by the hip- and knee-joints in the sitting posture; and, moreover, the sitting posture makes it difficult properly to wrap up the lower limbs. It is of great importance in the treatment of phthisis that the extremities should thus be constantly kept warm.

5. The most important result of the recumbent posture, however, is the entire repose given to the bony levers overlying the injured part. In the tranquillity of repose there is scarcely any motion of the chest wall. It is only in the effort of forced breathing, and in the almost spasmodic actions of coughing, that the individual ribs take part in the movements of

respiration;[1] and it is highly important that the range of these movements should be kept as small as possible. There must be no disturbance of underlying inflamed tissues, and no dragging upon any adhesions which may have formed between the two layers of the pleura. It behoves us, therefore, to choose that position of the body which will most completely spare the patient these efforts. The recumbent posture in all acute or non-quiescent cases is accordingly the best.

6. Closely allied to the last-mentioned result of the recumbent posture is its influence upon the state of fever, and generally upon all the other symptoms of the acute stages of the disease. It is a matter of common prudence to abstain from all exertion while the body is in a state of fever; but very few consumptives are willing, at any rate at first, to give in to this wholesome doctrine. It seems to be almost a characteristic of this disorder that the sufferer neglects this symptom, and perseveres in his ordinary avocations, when his evening temperature is often much above 100° F.

Often a restless energy seizes him, and he resents any interference with his liberty, except when imposed upon him by a systematic course of treatment. All the more is it necessary, therefore, to place rest in the forefront of our disciplinary course. In the words of Dr. Delpit, written eighty years ago, 'when rest is applied to the treatment of chronic maladies, it aids the action of remedies, resists the power of habit, facilitates the reaction of various organs against the morbific agent, and favours a healthy resolution.'[2]

[1] *On Stethometry*, pp. 51, 52. [2] *Dict. des Sciences Médicales.* 1820.

D. The Influence of Exercise, Massage, &c.—The treatment of chronic maladies by rest has, however, its dangers as well as its advantages. There is probably no remedy in the whole range of medicine which may not do harm if it be pushed to an excessive extent. This is certainly true of the 'Liegekur' in phthisis. It is acknowledged that in this disease our aim must be to raise the bodily powers to the highest point we can; but overmuch rest, without special precautions, may greatly endanger these powers.

By the lack of sufficient exercise it is well known that most of the functions may deteriorate; the muscles will waste and pass into a state of fatty degeneration; the nerves will lose their sensitiveness; even the special senses will become blunted and gradually fail in power. It is possible that some of the forces upon which we most rely to strengthen the body may fail us in our need, especially appetite and power of digestion.

We are told by the teachers of hygiene that 'muscular exercise is necessary for a sufficient elimination of carbon from the body,' that 'deficient exercise leads to weakening of the heart's action and probably to dilatation and fatty degeneration,' that 'it lessens both appetite and digestive power.' For the attainment of full power of resistance to disease, therefore, a certain minimum of exercise is as necessary as a certain amount of rest. As Dr. Weir Mitchell says, 'When we put the muscles at absolute rest we create certain difficulties, because the normal acts of repeated movement insure a certain rate of nutrition which brings blood to the active parts, and without which the currents flow more largely around than through

the muscles. The lessened blood supply is a result of diminished functional movement, and we need to create a constant demand in the inactive parts. But, besides this, every active muscle is practically a throbbing heart, squeezing its vessels empty while in motion, and relaxing, so as to allow them to fill up anew. Thus, both for itself and in its relations to the rest of the body, its activity is functionally of service. Then, also, the vessels, unaided by changes of posture and by motion, lose tone, and the distant local circuits, for all these reasons, cease to receive their normal supply, so that defects of nutrition occur, and with these defects of temperature.'

It has been shown by physiologists that five times as much air is respired when walking four miles an hour as is used in the lying posture, and one-third more CO_2 is excreted.

The problem that we have to face is, therefore, how to secure the good which repose may be made to insure—in other words, how to keep the injured lung at rest, and yet to keep the muscles and other organs in good condition. The problem is not insoluble.

In the case of neurasthenia, we know that Dr. Weir Mitchell solved it by calling to his aid massage and galvanism; and in some exceptional cases of phthisis we may have occasion to do the same, but it is seldom that we are pushed to this extremity.

In most cases of phthisis we can attain our object (1) by insisting upon a certain amount of rest in the recumbent posture, especially before and after eating; and (2) by limiting the movements of the body to such degree of exercise as will not quicken the action of the muscles of forced respiration.

In the more serious forms of phthisis, in which considerable exacerbations of fever are present, or where the breathing powers are greatly impaired, it will undoubtedly be necessary to impose rest in bed, or at least to restrict the patient to his couch; but this rigour will not usually have to be enforced for so long a time as to endanger the efficiency of the muscular system.

When feeding is carefully attended to, supplemented, if necessary, by rectal alimentation, it is seldom that lying in bed, even for a few weeks, leads to loss of strength or to loss of flesh. I have often seen patients, emaciated to a degree, regain their full strength and go on to complete recovery, even when confined to bed.

We may add that few of our phthisical patients are in this extremity; and, when the open-air system is boldly pursued, the fever usually soon subsides and the sufferers regain the power of gentle exercise. Then come into play our resources in the way of graduated exertion, but we have to take heed of the two conditions which I have ventured to lay down. When the body temperature does not often exceed 99°, but the patient is still somewhat feeble, it is well to persevere, for a time at least, with the lying-down treatment. Another class of patients who are best kept at rest are the decidedly dyspeptic and those who are rapidly losing weight. In some even of these cases, the circulation and the tone of the muscular system may be kept up by permitting gentle walking exercise, say for ten minutes every two hours; or we may trust to the mere transit from the open-air shelter to the dining room to keep up the muscular power

and to prevent stiffening of the limbs. Under this treatment the patient will usually put on flesh, and will gain sufficient energy to extend his exercise by degrees; and if there is still no real fever, he may gradually attain first to half a mile walk, twice a day, then to a mile, and so on.

Other exercises than that of walking will now also be admissible, such as short rides on a bicycle, or on a gently pacing hack, moderate games at croquet, or 'putting' on a green. In some cases, when there seems to be little danger of hæmorrhage, even a short game at bowls may be allowed; but in all cases the original restrictions must be observed. There must be no loss of breath and no over-fatigue; and the patient must recline for at least half an hour before, and an hour after, the chief meals. Sledging and carriage exercise generally, including the Bath-chair, may usually now be indulged in. All exercises in which there is a possibility of these restrictions being overpassed must be strictly forbidden; and hence lawn-tennis, golf, cricket, football, skating, tobogganing, and other violent games must be avoided until the patient is completely restored to health, and is quite out of our hands. Even after apparent complete recovery, it is doubtful whether *any* form of exercise, such as dancing or any other amusement, in crowded rooms should ever be indulged in; for this involves inhaling impure and dusty air, and thus lays the injured and susceptible lung open to reinfection by the bacillus of tubercle. There are, however, plenty of other amusements, usually carried on indoors, which can be managed *en plein air*, such as concerts and variety entertainments, chess, dominoes, cards, ping-pong, piano-

playing; and photography, outside the dark room, is an admirable resource. In many Alpine health resorts, hill-climbing is a favourite mode of carrying out graduated exercise, but it is one that needs extreme caution. Similar remarks apply to such forms of sport as rowing, fishing, shooting, and hunting. It might be possible to restrict a patient to the milder modes of carrying on these occupations—fishing and shooting from a boat, or following the hounds at a respectful distance, and jogging along country lanes on a quiet cob; but there is always danger that the excitement of the chase will carry our charges beyond the bounds of prudence, and hence it is better prohibited entirely. These remarks point to the first objection, to abuse of, or indulgence in, excessive exercise—namely, that it may lead to dangerous movements of the damaged lung, or to an over-strain of partially healed tissue. The regulations already insisted upon as to rest after meals, avoidance of fatigue, and loss of breath, will, however, usually be quite sufficient to curtail the patient's liberty with regard to allowable exercise. Even with regard to these we must recur to our first-mentioned principle—that Nature herself shows the way; that the rib-movements are but little restrained by the disease.

No active exercise which calls into action the muscles of forced respiration can be permitted so long as the rib movements over the parts affected are much restrained by the disease. It is not difficult for the skilled physician to form a judgment on this point. The eye and the trained hand will usually be sufficient for our purpose, but the stethometer may often, with advantage, be called to our aid.

Another source of danger from over-exertion in phthisis arises from the increase of blood pressure by which it is generally accompanied. It has long been known that severe exertion may, even in healthy persons, cause rupture of blood-vessels. It can readily be understood how important must be any rise of the blood pressure in a consumptive patient. While softening of the infiltrated lung is going on, and when the vessels are left with imperfect support, and when they are liable to be stretched by adherent parts, there must be increased danger of effusion of blood whenever there is any rise in blood pressure. Hence the need for increased care in the prescription of exercise, and for constant watchfulness lest the powers of the patient should be overtaxed.

Lastly, we must take account of the danger of nervous exhaustion, and of any influence which may lower the vital powers. It is well known that overfatigue, or depression of spirits, or weakening of the bodily power from a sudden chill will render the system more open to microbic infection of any kind, whether from the bacillus of tubercle itself or from other pathogenic organisms. Hence the necessity of avoiding all causes which may weaken the patient's power of resistance. Any excess of exercise may not only produce a dangerous condition of prostration, but may cause sweating and subsequent chilling of the body, such as may lay it open to microbic attack. In the open-air treatment there is, perhaps, less likelihood of the presence of micro-organisms, such as the diplococcus pneumoniæ, or streptococci and staphylococci ; and it is remarkable how free the inmates of such sanatoria are from all kinds of catarrhal affections ; but the lungs of

consumptives are generally full of germs of various kinds, ready to spring upon the weakened frames at the first suitable opportunity. Hence the constant care of the medical officers of such establishments, and of their attendants, to prevent the occurrence of what is called 'a chill.' Here, then, we again have cogent reason for extreme caution in the prescription of exercise. I conclude, therefore, that both exercise and rest are needful in the open-air treatment of phthisis. In the large proportion of our cases it will be found that most of their time will have to be spent in the semi-recumbent posture, and that only a very limited amount of exercise can be allowed.

The degree of *rest* that must be imposed will depend (1) upon the presence or absence of fever; (2) upon the efficiency of the digestive and assimilative powers.

The degree of *exercise* will depend (1) upon the muscular and bodily vigour of the patient; (2) upon the movements of the ribs allowed by the disease in forced respiration, and especially of the bones over the site of the inflamed parts of the lungs. Ample provision must, therefore, be made in a sanatorium both for the 'rest cure,' and for such gentle exercise as may be obtained within the boundaries.

E. Baths and Cleanliness.—Daily ablution of the whole body must be enjoined, and, with the assistance of the nurses, must be carried out even with the more delicate patients.

The air from the surface of the body arises close to the channels for respiration, and must therefore be kept as pure as possible. Hence the need for entire cleanliness of both person and clothing. (See 'Clothing,' pp. 31–32.)

If possible, most of the washing should be performed with cold water. The skin must be gradually braced up to withstand occasional cold, and the whole body inured against possible chill.

General and local treatment by baths is also frequently needed.

We will not attempt to consider the *modus operandi* of all the various forms of water treatment in use at sanatoria; it is sufficient for our present purpose to approve of its judicious use; to deprecate anything likely to depress the vital powers, especially in patients with weak circulation or showing signs of inadequate reaction; and to protest once more against the tendency to exalt a means of undoubted value into an exclusive method of cure. Rightly used, cold sponging, either local or general, is of great service. When gradually advanced, it produces a healthy tone in the skin, diminishes the sensation of draught, inures against cold, and generally strengthens the system. It is essential that the powers of the individual be carefully studied, and that in most cases at the outset the hands and feet should be kept warm, the nervous system guarded against too much shock, and the circulation promoted. For delicate persons, the method of cold sponging used at Matlock is excellent. It consists in placing the hands of the patient over a hot pad resting on the solar plexus, and making him stand in warm water while he is sponged or douched. A warm bath towel is then wrapped round him, and he is well rubbed down. This of course demands the assistance of an attendant and a room for the purpose. (See 'Management,' Essay III. p. 85.)

More robust patients can take the ordinary sponge

bath in their own rooms. The local and general applications of water, hot or cold, will also have to be made by a skilled bath assistant, under the direction of the doctor.

F. BLOOD-MAKING.—The title chosen by Dr. Weir Mitchell for his work on the treatment of hysteria or 'neurasthenia' was 'Fat and Blood, and how to make them.' The importance of these factors in the cure of phthisis is even greater than in the special disease for which it was proposed.

The mode of action of the agents which he employed, therefore, deserves consideration in any work on the treatment of phthisis. These agencies are, in fact, used in most sanatoria, but I have mentioned them incidentally in Essay II., and shall therefore pass over the subject for the present.

G. COMFORT, WARMTH, LIGHTING, AND AMUSEMENT. Among the leading directors of existing sanatoria we find much difference of opinion as to the extent to which some of these adjuncts of the treatment may be allowed.

1. *Comfort.*—It is interesting to note that in the recent competition for the King's Prize the Advising Committee place 'comfort' in the forefront of their instructions to competitors.

The proviso that 'the accommodation for all patients is to be comfortable' will sound strangely to the conductors of some of the more recently built sanatoria. Comfort is in them relegated to the last place; and is only to be found when the patient is confined to bed, if even then. In these institutions the bedrooms are designedly erected at a considerable distance from the dining-hall. There are no covered ways; and those patients who do not take their meals in bed have to walk, in all weathers, across the inter-

vening space. They are encouraged to do this without covering to their heads. If their clothes are wetted by rain or dew, or their feet soaked in melting snow, they are told not to change their things, but to let them dry on their persons. At the same time, strong currents of air are necessarily passing over their bodies. Even in the bedrooms they are expected to wash and dress with the windows, and often the doors, open ; and the radiators are seldom used except to dry the towels, &c. There is not much chance of comfort under these conditions. These arrangements are surely contrary to all ordinary hygienic rules, and it is difficult to see what good can possibly be gained from them. Genuine open-air treatment does not countenance senseless exposure. The object, it has been stated, is to remove the dread of catching cold; and, assuredly, in the pure air of these sanatoria this contingency is of very rare occurence ; but, on the other hand, such disorders as rheumatism, pleurisy, and even pneumonia are not by any means uncommon. The depression of the vital forces, due to local chilling of the body, is only too likely to counterbalance the vivifying power of the fresh air ; and it is forgotten that, though the air itself may be free from the microbes of catarrhal affections, the lungs of the invalids themselves are frequently charged with pneumococci, streptococci, staphylococci, and other pathogenic organisms. These are ready to take advantage of any temporary weakening of the powers of resistance. Nothing gives so favourable an opening to these microbes as a sudden chill, or an unequal exposure of the body to cold. It depresses the vital powers, and gives a shock to the nervous system such as will often pre-

cipitate an attack upon the weakest portion of the frame.

In our opinion the danger of such occurrences, especially in the early days of residence at a sanatorium, makes it necessary to provide covered ways for the passages from the bedrooms to the dining hall. This is desirable in the interests of both the patient and the attendants. Ample openings must be left for the free perflation of air through and around these passages; but some protection from rain or snow, and from too violent gusts of wind, should be provided. Similarly, in the stage of debility, means must be given for warming the bedrooms to a temperature of at least 45° or 50° F. during the hour for dressing or undressing; and the more delicate invalids should have competent assistance in taking their baths and in dressing.

2. *Clothing.*—The right sort of clothing greatly conduces to the comfort of patients; and, as much as possible, it should be under the doctor's control.

Not only warmth but purity of clothing should be sought after. Hence the value of light, fleecy, woollen garments, both for under and upper clothing.

Pettenkofer has shown, by means of tiny anemometers, that there is continual circulation of air going on within our clothing. This tends to purify it, the constant aeration oxidising the organic vapours arising from the body. Whenever, in order to screen the skin from very cold air, we are obliged to wear garments of close texture, we lose much of this purifying influence. Extraordinary care must therefore be taken to cleanse such garments immediately on their removal from the body by hanging them out in currents of air,

and, if possible, in the sunshine, in dry heat, or in a steam disinfector.

For the same reason, all clothing should be frequently changed, and must never be worn night and day.

Loose overcoats and wraps must be provided by the management for those who lie in the shelters or in the open grounds; and these must be frequently purified by steam heat, preferably in Professor Delépine's Disinfector.

The best material for keeping cold out, and warmth in, is Shetland wool. Its great disadvantage is its tendency to shrink; but this may be overcome by washing in cold water, or by dry cleansing in low steam heat, as in Professor Delépine's Disinfector.

Other woollen or Angola underclothing is good. Sheepskin and fur are useful for wraps generally; and if the wool or fur is worn outside, they are kept fairly pure by the outer air. Only, in this case, the undergarments will need special care to purify them, unless the skins are also made freely porous. There is nothing much more noxious to the air breathed in their immediate neighbourhood than the popular rabbit-skin 'chest-protector.' It usually exhales impure organic vapour, and makes the underlying skin relaxed and tender.

Close-fitting outer garments, of cloth or fustian, are also undesirable. Bed clothing should also be light and porous. Hence no close-woven counterpanes should be allowed, and porous cellular sheets are better than ordinary calico or linen.

3. *Heating.*—This is best accomplished by hot water or steam, or electricity, provided that these

means can be made to work noiselessly; but, as we shall see hereafter, it is desirable to furnish open grates for occasional use.

4. Electric light must be supplied everywhere, even in the shelters, verandahs, and balconies. Electric heaters would also be very useful.

5. *Amusements.*—I have already, under the head of 'Exercise,' to some extent discussed the question of whether certain recreations are admissible or desirable; and I have ventured to indicate the principles upon which, in my opinion, they may, or may not, enter into the daily life of the consumptive invalid; but a few more words must be said as to the extent to which social intercourse between the patients may be permitted. Upon the answer to this question depends the design of the architect of the building. In all the original sanatoria, such as Görbersdorf and Falkenstein, there are long 'galleries,' verandahs, or covered balconies or 'loggie,' in which many patients lie on their 'chaises longues' for most of the day, and often after sunset. They are placed sufficiently near to one another to permit of conversation, or the playing of such games as chess, draughts, dominoes, &c. It is not supposed that such congregation of patients together is at all hurtful. On the contrary, it is regarded as likely that such 'distraction' is beneficial; and that the chatting and talking will not only amuse the patients, but will tend to cheer and encourage them to maintain all the minutiæ of the treatment.

On the other hand, there are many who consider that the provision of 'galleries' or recreation rooms, or any places of assembly, is directly antagonistic to the treatment. The collection of invalids under one

roof, however freely it may be open in front or ventilated above, is detrimental, spoiling the otherwise pure air and increasing the danger of reinfection. In spite of all precautions in the way of spit-cups, paper handkerchiefs, &c., it is considered possible that the spray from uncontrollable coughing may shed the bacillus into the atmosphere. The chat and gossip also do harm rather than good, overworking delicate lungs and encouraging introspection and discussion of symptoms. The holders of these views have therefore abolished verandahs, recreation rooms, and shelters of every description; and the only asylums open to the invalids in wet or unfavourable weather are their bedrooms or the dining hall. Some patients are also forbidden even to read any book likely to excite or over-interest them. The truth, as usual, lies between these two extremes, and *again* discrimination between patients is necessary. There can be no hard and fast rule. Some patients are of a calm and placid disposition, and will take no harm from lively conversation. Others are of an excitable nature, and certainly need some restriction upon their intercourse.

In a well-found sanatorium provision must be made for each class of patients. For some, even solitude may be good; and for these it is surely well to provide shelters either open to the sky, or covered but ventilated above, and capable of being turned away from the wind. For others a *solitude à deux* may be better; and to those who are in a very early and quiet stage of the disease, in whom there is no reason to fear results of moderate exertion or over-excitement, there may be permitted such a degree of social intercourse, in the open air, as may prevent them

becoming dull, or disgusted with their treatment. It should also always be possible to wheel a reclining chair out of a bedroom on to a still more open verandah or balcony ; and for those who can walk a little, shelters should be placed in different parts of the grounds, so as to vary the view and environment.

In these they can be shielded from rain and strong wind, and yet live as nearly as possible in the open air. Incidentally I may remark that concerts should not be given where there is a danger of disturbing those who are seriously ill ; but covered bandstands might be placed in the grounds at a sufficient distance from the pavilions.

H. MEDICAL AND SURGICAL TREATMENT.—As few drugs as possible are employed in conjunction with open-air treatment ; nevertheless, it is necessary to provide certain drugs, applications, &c. It is surely good to take advantage of any definite knowledge that has been obtained in the past as to the value of medicines, the proper use of tuberculin, formalin, creasote and its derivatives and compounds, lecithin, iodoform, codeia, or other preparations from opium, salol, the salicylates and other antipyretics, cod-liver oil, arsenic, bismuth, zinc, digitalis, strychnine, and various styptics. Nor must external applications be forgotten, such as stupes, blisters, iodine, cupping, &c.

Surgical treatment is also sure to be needed for empyema, thoracic abscesses, even occasionally for vomicæ and for cases demanding laryngotomy.

Throat troubles will need constant attention ; accordingly, all the most modern appliances for these purposes will have to be provided ; also a well-lighted,

airy operation room, and a dark room for laryngoscopic work, for X-ray investigation, and photography. A bedroom and small ward must be provided for the operation cases.

I. EDUCATION AND DISCIPLINE.—I have already passed in review most of the points of importance on which the training of the patients in healthy habits will depend. Although a prolonged stay in a sanatorium is usually needed, and hasty judgments as to cure are much to be deprecated, yet, if the training be thoroughly carried out, a residence of even a few weeks only would render consumptives much less dangerous to those who live with them in the slums, or even in the ill-ventilated dwellings of the upper classes; and their examples, in such matters as insisting upon as much ventilation as can be obtained, abolishing the spitting habit, and properly disposing of their own sputum, would constitute an important means of both educating the public and conducing to their own ultimate recovery.

K. TREATMENT AND DISPOSAL OF SPUTUM AND OTHER EXCRETA.—I have assumed throughout that, in any sanatorium for the treatment of tuberculosis, extreme care will be taken to prevent any excretions, especially sputum, from being a source of danger, either within the institution or outside.

The excreta will therefore be treated with suitable disinfectants at the moment of their discharge: alvine discharges and urine with sufficient izal, acidulated corrosive sublimate, or some other fluid whose efficiency has been thoroughly tested.

Pocket flasks and spit-cups will be, doubtless, properly prepared and distributed night and morning;

and only Japanese or English paper handkerchiefs and napkins will be used, and afterwards destroyed. If retained for a time on the person they will have suitable receptacles, which will also be cleansed and disinfected daily.

Clothing will have to be periodically disinfected in a steam oven, and also all linen before it goes to the laundry. Large disinfecting ovens, of the best pattern, will therefore have to be provided.

L. The Medical Attendants and Staff.—In carrying out the discipline, the character of the medical officer plays an important part. It is not only desirable that he should be practically acquainted with all details of treatment, but he must possess a firm and decisive will and demeanour. It is not needful for him to put on an imperious manner or to 'dragoon' his patients into obedience; but he must be a man of dominant, though quiet, power; who will be able, with tact and discretion, to get his will obeyed, to soothe the fears of some, to combat the prejudices of others, and to control the careless and insubordinate. As to his duties, they have already been indicated under the heading 'Advantages of Sanatorium Treatment' (p. 6).

The matron and nurses ought to be specially trained for the work. The nursing of consumptive patients is quite different from, and in some respects more difficult than, the nursing of ordinary hospital cases. The invalids are seldom confined to bed, and they have to be watched and guarded in all their haunts. They are also usually more capricious and inclined to be insubordinate than the latter. A prolonged hospital training for our nurses is, therefore, neither necessary nor desirable. Probably one year or

two years would suffice to teach them the need for implicit obedience to orders, and methodical, orderly, and cleanly habits ; also, accuracy in noting symptoms, amount and kind of food taken, temperature-taking in the most efficient manner, whether in the rectum or otherwise. They should be in sound general health, and naturally deft, neat-handed, gentle, and good-humoured ; but they would probably need to be specially taught the preparation of peptonised foods, the skilful administration of nutritive or other enemata, the bathing and washing of delicate and irritable patients. Above all, the need of *tact* in the management of these invalids must be particularly enjoined upon them.

Essay II

ON CERTAIN BODILY CONDITIONS RESISTING PHTHISIS

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ON CERTAIN BODILY CONDITIONS RESISTING PHTHISIS

Natural immunity of man—Morbid conditions resisting tubercle—'Venosity'—'Cellular plethora'—Blood counts in diseases resisting phthisis—Condition of the blood in phthisis—Blood counts in phthisis—Preventive and curative influence of 'Cellular plethora'—Phagocytosis—Principles of feeding and blood-making in phthisis.

HUMAN beings are classed among the animals naturally resistent to tuberculosis; and, although post-mortem examinations show that at least 30 per cent. of mankind bear traces of the malady, this fact is really favourable to the classification, since a large proportion of the cases must have recovered without treatment, many of them without being even aware of the presence of the disease.

It is probable that most healthy persons are able to resist attacks of the tubercle bacillus, if this organism is unaided by previous local injury or by some debilitating ailment in the subject of the attack; moreover, the more closely the bodily condition approaches perfect health the less likely is tubercle to take root and spread through the system.

Immunity from infection is, in fact, dependent upon the efficiency of the various protective agencies of the body, the straining action of the hairs at the entrance of the air passages, the tortuosity and the entangling mucus of these channels, the full expansibility and elasticity of the lungs, and their freedom from restraint.

These safeguards prevent the organisms contained in tuberculous dust from lodging in the lungs for sufficiently long periods to permit of pathogenic action.

In case of an actual invasion by comparatively small numbers of organisms, the internal protective forces also come into play, and antitoxic and phagocytic action takes place. By means of these, except in the case of peculiarly susceptible persons, almost complete immunity is secured. Usually also the tubercle bacillus needs the adventitious aid of other organisms before it can penetrate the defences of the human body. But it is not only in perfect health that the human body is thus immune. It has long been recognised that there are also certain morbid conditions of the human frame which are to some extent antagonistic to tuberculosis.

The morbid conditions thus opposed to phthisis are enumerated by Dr. Walshe in his work on 'Diseases of the Lungs:'

1. Carbonaceous disease, *i.e.* anthracosis.
2. Cyanæmia.
3. Rickets.
4. Gout and calculous disease.
5. Cancer.
6. Diathetic skin disease, *e.g.* pemphigus.
7. Emphysema.
8. Nodular pulmonary apoplexy.
9. Active organic cardiac disease. Aortic aneurism. Angina.

At p. 450 he says: 'That active cardiac disease and active tuberculosis rarely co-exist is indubitable.'

Rokitanski, in his work on 'Pathological Anatomy,' had already mentioned most of these pathological con-

ditions as opposed to tubercle, and he grouped them 'in a twofold series, according as the venous habit and cyanosis are dependent upon the heart or the lungs.'

He further adds (*a*) increased density of the lungs produced by coarctation of the thoracic spaces, *e.g.* as in hunchbacks or certain forms of spinal curvature; (*b*) pleural effusion; (*c*) pregnancy and other encroachments upon the abdominal space and consequent narrowing of the thoracic cavity—*e.g.* from cystic formations or dropsy; and (*d*) intermittent and other fevers. Rokitanski boldly ascribes the immunity arising from all these states to the high degree of '*venosity*' produced by them, but he does not appear to have sufficiently verified some of his assertions, and his conclusions are several times called in question by others, notably by Dr. Wilson Fox with regard to pregnancy, pleurisy, heart disease, and spinal curvature. The latter author, however, expressly states that 'conditions producing passive pulmonary congestion are adverse to the production of phthisis;' and he illustrates his remark by reference to emphysema and heart disease. He further says: 'It is a matter of common experience that, in families in whom gout is common, phthisis is unknown.'[1] He suggests that the rarity of recent tuberculosis in emphysema may be due (1) to the non-vascularity of the lung in such cases and atrophy of the alveolar wall, (2) to the apical site of emphysema, and (3) to the differing age incidence of the two diseases.

Dr. James Pollock, in the 'Prognosis of Phthisis,' agrees that dilatation and hypertrophy of the heart, gout, and rheumatism all retard the process of phthisis,

[1] *Diseases of Lungs*, p. 548.

and says that when this disease is complicated with emphysema its average duration is three times longer than in other cases.

Ancell, in his work 'On Tuberculosis,' also discusses the partial exemption from tubercle conferred by different diseases. He dismisses cancer and, to some extent, agues; but he also affirms that 'gout and phthisis rarely occur together.' Fournet says (vol. ii. p. 837) 'never.' He remarks that 'tubercle is less frequently found in children who have died from rickets than in those who have died from other diseases' (p. 32).

Ancell further states that chronic venosity or defective arterialisation of the blood, however produced, seems to confer exemption from tubercular diseases.

It would perhaps be difficult to bring these allegations, as to even partial immunity, to the test of figures. Louis, James Pollock, and Austin Flint are the authors who have most systematically attempted the statistical method, and undoubtedly their results are interesting, though they can hardly be described as conclusive. So far as they go, however, they corroborate the observations of the able men already quoted; and thus we may be sure that these latter had strong grounds for their opinions. Their conclusions are also, I think, in accord with the general experience of the profession, except perhaps Rokitanski's assertion respecting hunchbacks.

I have noted at least two cases of phthisis in hunchbacks, and Dr. Moritz, physician to the Manchester Hospital for Consumption, &c., writes to me that he remembers two cases of phthisis in hunchbacks, and remarks that 'curious to say, this morning, at

Hardman Street, I saw a third and fourth case with considerable kyphosis and lordosis, but not much deformity of the anterior part of the thorax,' but, as he says, 'after all, one does not see many hunchbacks.' I should, however, agree with Dr. James Pollock when he remarks that 'deformed chest is very uncommon in phthisis,' and that 'psoriasis is rare.'

I have also seen phthisis in more than one case of mitral stenosis, but whether there was compensation in these cases is not certain. In several instances in my experience pregnancy has seemed to temporarily arrest the disease, but after delivery it progressed with still greater rapidity.

Gout and gouty skin diseases are unquestionably very rare in phthisis, and so are extreme cases of emphysema and cyanotic diseases generally, though they do occasionally occur.

On the whole, therefore, there are perhaps sufficient grounds for concluding that some immunity from phthisis is conferred by the diseased states which have been mentioned.

If so, it is natural to inquire whether there may not be some bodily condition common to all these disorders, a condition which presents a hindrance to the entrance, or to the growth, of the tubercle bacillus.

It seems possible that this common bodily state might be that peculiar condition which Rokitanski calls 'venosity' for want of a more definite name.

Venosity probably means a plethoric condition of the capillary system of blood-vessels, with imperfect aeration of the blood—in other words, an excess of red blood corpuscles, increased alkalinity of the fluid, and increase of carbonic acid. It is difficult to say which

of these conditions is chiefly antagonistic to tuberculosis ; perhaps all three are so.

In reference to the alkalinity of the blood, we may adduce the opinions expressed by Professor Halliburton.[1] Speaking of the blood, he says : (1) 'Venous blood contains more diffusible alkali than arterial blood and is more bactericidal. (2) Increase of alkalinity means increase of bactericidal power.'[1] (3) 'In a condition like diabetes, where the blood is less alkaline than it should be, the susceptibility to infectious disease is increased.'

'Alkalinity,' he says, 'is probably beneficial because it favours those oxidative processes in the cells of the body which are so essential for the maintenance of healthy life.'

Even in persons subject to acute attacks of gout, there is probably in most a plethoric condition of the venous system.

It is still more interesting to note that 'polycythæmia,' or 'cellular plethora,' as it is called by Da Costa, is also common to most of the diseases I have assumed to be hostile to the bacillus of tubercle.

Thus Da Costa[2] notes this condition in cyanosis, peripheral stasis, as in emphysema, asphyxia, uncompensated heart disease ; and in an acute paroxysm of gout he counted over seven millions of corpuscles per c.mm.

In asthma also these bodies are usually in excess ; and in valvular heart disease, accompanied by stasis, dyspnœa, and cyanosis, a more or less decided poly-

[1] Address on the Present Position of Physiology ; *Lancet*, vol. ii. 1902, p. 790.

[2] *Clinical Hematology*.

cythæmia is found, the count varying from six to eight millions. These changes are thought by some authors to be specially prone to occur in affections of the mitral valves.

It is true that an increase of the red corpuscles takes place with inspissation of the blood *from any cause*, as after food, or during starvation, after diaphoresis or the action of emetics or purgatives; in diarrhœa, dysentery, &c.; but these are usually temporary conditions, and can, therefore, be easily marked off from the more permanent states of the blood.

Owing to these latter causes, the count of red blood corpuscles may also be temporarily increased in phthisis, but usually in tuberculosis, though there is a moderate loss of hæmoglobin, there is little or no change in the number of red corpuscles (Da Costa).

Condition of the blood in phthisis.—This point opens up another branch of the subject, namely, the state of the blood supply in phthisis in persons who are in its early stages, and in those who are progressing towards an arrest of the disease.

There is a general consensus of opinion that in the early stages of phthisis there is a diminished quantity of blood, and that the heart and aorta are small. Louis observed in 112 cases, in which death was caused by phthisis, that the heart in the majority was small, and very frequently not more than one-half or two-thirds its ordinary size.

At this time also there is often some lessening in the number of the solid elements, and a deficiency of colouring matter.

It is probably owing to this lack of hæmoglobin that the grey pallor of the early consumptive is due.

It is not true anæmia, and the complexion is not that of chlorosis, but is rather muddy than yellow. The contrast to this picture presented by patients at sanatoria towards the end of their stay is very striking.

Patients in whom the disease is arrested are, for the most part, florid and full of blood, approaching in many cases to actual plethora.

I have seen a number of persons who have been at Nordrach or at institutions where a similar course of forced feeding has been practised. Some of them had broken down with disordered digestions, but most of the others had the appearance of rude health. They had not only put on flesh, but were ruddy and sunburnt, looking like farmers, some of them even more like publicans. There could be little doubt as to their having made blood ; but whether there was venous congestion or not could not well be determined. Dr. Johns, however, tells me that hæmorrhoids are very common among such patients.

It is generally understood among physicians to sanatoria that the course of treatment pursued therein enriches the blood both with more red corpuscles and more colouring material ; but I am not aware of any definite instrumental research on these points, comparing the incoming with the outgoing patient. It is one that certainly ought to be undertaken.

I have made estimates of the red blood corpuscles with a Gower's hæmocytometer in a few patients, some in my own practice, and some kindly selected for me by Dr. Johns from his sanatorium at Alderney Manor. The results are given in the following table, and I think the counts are fairly trustworthy, seeing that the numbers in each square varied very slightly.

(Dr. Coles also kindly verified my instrument by his 'Thoma-Zeiss,' and found it gave correct results.)

Initials	Age	Sex	Stage	Red corpuscles per c.mm.	White	Hæmoglobin	Remarks
J. R.	25	M.	II	4,800,000 (mean of two)	—	—	Chronic, 8 years, whole right lung, diffuse tissue
T. B.	22	M.	I	5,300,000	—	—	Early, both sides, right upper lobe. Left slight
R. E.	26	M.	III	5,820,000	—	—	Both lungs, right cavity and consolidation. Left slight
S. T.	28	M.	III	7,600,000 (mean of two)	—	—	Left upper cavity at apex. Alcoholic
F. N.	22	M.	I	4,800,000	—	—	Slight physical signs. T.B. plentiful. Hæmorrhagic
B. F.		M.	III	6,300,000	5,000	85	Cavity, left apex
J. C.	26	M.	II	6,020,000	5,000	81	Acute right upper lobe. Gastric troubles
T. S.	28	M.	I	5,010,000	6,000	95	Full-blooded, right apex, 5 months' residence
J. B.	30	F.	III	4,910,000	—	—	Two months at Stornfield Park
E. G.	40	F.	III	5,460,000	—	80	Acute right upper half cavity and consolidation
L. A.	28	F.	?	4,180,000	—	70	Doubtful, rough breathing, right apex. No T.B.
S. G.	21	F.	I	4,850,000	6,000	90	Slight early case. Right apex
F. C.	29	F.	I	4,675,000	7,200	78	Anæmic-looking, left apex, crepitation

It will be noticed that there are several very high readings, and that the averages of the counts are large both for males and females. For males the average is 5,825,000, and for females, excluding the one doubtful case, it is 4,973,750, thus considerably exceeding the averages in healthy persons.

It is not surprising that 'erythrocytosis' should be the result of sanatorium treatment. Most of the means used certainly tend to improve the colour of the blood, and probably increase the number of red

corpuscles, such as the exposure to sunlight, the abundance of pure air and perhaps of ozone, the recumbency before and after meals.

Moreover, among the circumstances enumerated by Da Costa as promoting erythrocytosis, we find the use of cold baths, massage and electricity, the eating of animal food, and the resort to high altitudes.[1]

With regard to the last-mentioned point, the greater resistance to tubercle which has been noted at high altitudes, and also to the well-doing of consumptives at places like Davos, St. Moritz, and in the Cordillera, it is interesting to observe, as Da Costa says, 'the invariable occurrence of polycytosis both in the inhabitants of elevated districts and in occasional visitors, a fact still inadequately explained.'

'Viault counted 8,000,000 erythrocytes in the residents on the Cordilleras, at an elevation of more than 14,000 feet above sea level. Egger counted 7,000,000 at Arosa, at a height of 6,100 feet; and Wolff and Koeppe found an average of 5,900,000 at Reiboldsgrun at 2,257 feet.

'Oliver relates the interesting experience of finding in his own blood, during a stay at Davos Platz, at an elevation of 5,200 feet, an increase of corpuscles within twenty-four hours after his arrival, the maximum count, 5,550,000, being attained within seven days, and the number declining within five days after his return to London.'

Da Costa gives a table, by Koeppe, illustrating the fact that the higher the altitude the greater is the number of corpuscles.

[1] Limbeck (Syd. Soc., clxxiv. 189) quotes Marestang to the effect that sea voyages may also produce an increase in the number of red corpuscles.

He himself thinks that concentration of blood explains the polycythæmia of high altitudes; this change being due largely to the great loss of body fluids (Grawitz), and partly to the increased arterial tension (Oliver) arising from a rarefied atmosphere.

Koeppe and others held different views (see also Limbeck, *l.c.* p. 188), but so far as our purpose is concerned the explanation is not of much importance; the main point to be observed is that, at these high altitudes, admittedly so beneficial to consumptives, there are large proportions of red corpuscles in the blood.

It is not easy to account for the *preventive* influence of 'cellular plethora,' and it is still more difficult to see how it can assist the *cure* of tuberculosis.

In prevention it may perhaps be allowable to conceive that, as Professor Halliburton shows, the venous state of the blood may cause the destruction of the bacillus on its first entrance into the body, before it has entrenched itself within a tubercle.

If a batch of tubercle bacilli, sufficiently large to cause infection, should be borne into the recesses of the lungs in the form of tuberculous dust, it may lodge in an alveolus, or may even gain access into the lung tissue by way of pseudo-stomata or by means of some local lesion. But in such a vascular organ as the lungs it will at once be brought into close relation with the blood stream, and if the blood current is slow and the blood itself imperfectly aerated, opportunity will be given for all the bactericidal powers of both blood and tissues to be exerted upon the intruders. The disease may thus be averted at the outset.

The 'cure' of the disease, when tuberculosis has been established, is a different matter. A tubercle,

once formed, with its garrison of bacilli in its interior, is a kind of fortress. It is a non-vascular body. The specific organism within it is completely protected from the direct influence of the blood. The layers of exudation cells, in various stages of degeneration, which surround it are to a great extent 'blood-proof,' and are only penetrated by small quantities of intercellular fluids, by gases, and, perhaps, by the vapours of volatile substances. All this renders it difficult to act directly upon the organism.

Moreover, consumption is certainly not cured by deficient aeration of the blood, though, as we have seen, it is quite possible that it may be prevented thereby.

The results of 'open-air' treatment show that what is needed for success is 'hyper-aeration.' Yet it is probable that an excess of red blood corpuscles is as important in the cure as in the prevention of the disease. An increase in the number of these bodies, together with an increase in their contained hæmoglobin, means greater power of absorption of gases, whether oxygen or CO_2.

We can thus see that 'polycythæmia' may be of great importance in both cases. If oxygen, in the nascent state, is present in large quantities in the blood, and if, owing to a plethoric stasis in the vessels, it has a longer time in which to act, arterial cellular plethora may operate in the cure of phthisis as effectually as venous plethora acts in its prevention. The mode of action in the two cases may be different, and yet they may each be assisted by an increase in the number of purveyors of gases. From these considerations, then, it would appear that, for the *cure* of phthisis, it is not 'venosity' that is required, but an abundance

of arterial blood, rich in all the elements of this fluid.

The quality of the blood may affect the bacillus in another way. It may to some extent determine the nature and quantity of the nutriment conveyed by osmosis to the bacillus. If this nourishment be, as conjectured, some volatile organic substance such as is contained in air rendered foul by respiration, then hyperoxidation will be likely to destroy this material long before it can reach the hungry parasite.

Again, as we have seen, the condition of the blood may be able to control the admission to the tissues of other organisms, known to be the active allies of the bacillus of tubercle; such bodies, for instance, as streptococci, staphylococci, pneumococci, and tetragonus

If mixed infection by these and other organisms can be averted, the bacillus of tubercle, in the vast majority of cases, may remain a comparatively harmless vegetable, and can be left, shut up in its own fastness, to stew in its own tuberculin until it dies. In the course of time it will either be starved out or lose its virulence, and the further progress of the disease will be stayed.

Phagocytosis.—In considering the resisting powers of the organism, the question of phagocytosis also comes naturally within our purview.

In a note on this point, Dr. Coles makes the following remarks:

'The introduction of a bacterial poison into the human body is attended with a reaction on the part of the white cells at the seat of injury, and in the blood system generally.

'The increase in the number of leucocytes in the blood usually bears a ratio to the degree of irritation, and by this means Nature attempts to overcome the disease.

'"The process of inflammation is essentially the endeavour on the part of the organism to promote the migration of leucocytes, to aid in the inclusion and destruction of the irritant." (Sherrington.)

'If the irritant is small in amount or of little virulence, the reaction, as shown by the presence of leucocytosis, is also slight. When, however, the poison is overwhelming in quantity or its virulence is great, the white cells do not increase in number, and the blood shows very little numerical alteration in its white corpuscles, and it is in these cases that a fatal termination may be expected.

'In certain diseases, of which tubercle is a good example, the poison very slowly produces its effect, and no leucocytosis is generally seen. It has become a fairly universally accepted fact that leucocytosis does not occur in any tubercular diseases which are unattended by complications.

'In cases of pulmonary tuberculosis, in which a pneumonic process is taking place around the original tubercular focus, or in those cases which are generally spoken of as 'mixed infections,' in which pyogenic organisms are present, the leucocytes in the blood are frequently greatly increased in number.

'It is probable that the white blood corpuscle as seen in blood or tissues has the power of attacking living bacteria, and by that means rendering them harmless. More recent observers, especially Hankin and Kanthack, have shown that the white corpuscles

also produce their beneficial effect by secreting substances (alexines) which are toxic to the germs.'

Now, at this point comes in the influence of sanatorium treatment, and especially its influence upon the blood. In order to increase the fighting power of the leucocytes of the body it is essential to render the body generally, and the leucocytes in particular, as fit as possible. This is attained by the modern treatment of phthisis by pure air, good feeding, rest, &c.

In a valuable paper Dr. Galbraith[1] says: 'In cases treated by the open-air method and on a diet rich in animal nitrogen the characteristic features of the blood counts are (1) a moderate constant leucocytosis, (2) a large absorptive lymphocytosis, and (3) an almost constant eosinophilia, the eosinophile cells varying from 4 per cent. to 5 per cent. of the total leucocytes. . . . The total number of the leucocytes varied, in one case, from 10,000 at 8 A.M. to 19,000 at 3 P.M. This exceptionally large increase occurred after two meals consisting mainly of nitrogenous food.'

He further remarks: 'If it be true that the leucocytes have a special antibacterial action, and that changes in them are evidence of a reaction to poisoning, which may be common to all tissues, but is demonstrable only in the blood, then only those constituents of the diet which are known to produce or favour this reaction need be in excess of the normal.' Again: 'A diet mainly animal furnishes the largest amount of nuclein derivatives in proportion to the quantity taken, while, if properly administered, it throws least strain upon the organism.'

'Some investigators have considered that the

[1] *Brit. Med. Journ.* March 14, 1903, p. 600.

leucocytes in the blood of phthisical patients should be stimulated, and that an artificial leucocytosis should be produced. To some extent the so-called "sun-baths" accomplish this.

'As Büchner says, "the injection of various substances, such as physiological saline solution, bouillon, &c., into the body of a guinea pig may be followed by a temporary increase of the natural resistance, which may even simulate a specific immunisation."

'Landerer has for several years successfully treated phthisis by the injection of cinnamic acid, an agent that produces leucocytosis.

'Others have given, for the same purpose, yeast, nuclein, or similar substances by the mouth, and have claimed to have obtained very decided improvement by these means. Perhaps also the use of blisters comes within the same category.

'In any case, it may be safely said that such methods are based on a scientific principle, next only in importance to the attempt, so far unsuccessful, of rendering the bacillus of tubercle *in situ* inert.' (Coles.)

The composition and the extent of the bactericidal power of the blood may thus become of extreme importance in the cure of consumption.

I believe that the success of sanatorium treatment may indeed to some extent be explained by its blood-making power, a power which may even have to be pushed beyond the limits of perfect health.

I am aware that this is not the explanation usually given. The popular theory is that, by purely hygienic means, the health of the patient is so completely restored that his tissues and his blood are able to make a successful stand against the attacks of the bacillus.

Doubtless the restoration to the consumptive of such a degree of health as is possible to him must improve his power of resistance to the microbe; but I consider that sanatorium treatment does far more than merely improve the general health, and thus that it deserves something more significant than the title of 'Traitement Hygiénique' given to it by some French authors.

Each factor of the sanatorium treatment has indeed a distinctly remedial as well as a hygienic aim.

Thus, (1) the abundance of fresh air and sunshine, and the measures of disinfection practised in all sanatoria, create an almost 'aseptic atmosphere,' and banish most pathogenic organisms from the immediate environment of the patient.

(2) The prolonged periods of absolute recumbent rest, prescribed for all acute cases, give the greatest possible measure of immobility to the ribs over the inflamed portions of the lungs. This rest, together with the absence of irritation by dust or organic matter in the air, soothes cough and reduces fever.

(3) The graduated exercises and massage improve appetite, and thus tend to increase weight and assist the other measures in improving the general tone—in other words, the nerve power of the subject.

(4) The large allowance of food of all kinds, and especially of fats and strong animal food, causes in most cases a great increase in weight, thus also increasing the hopefulness and buoyancy of spirit in the patient.

It may be affirmed, therefore, that each of the factors in sanatorium treatment takes part, not only in the hygienic improvement of the patient's condition, but also in a direct attack upon the disease itself.

May there not, however, still be something more in this treatment than has hitherto been recognised? It is remarkable, to say the least, how all the before-mentioned agents in the cure combine, as if in a sort of converging fire, to bring about that very condition of 'cellular plethora' which we have seen to constitute so potent a protection against tubercle. Fresh air and sunshine, rest in bed, a full animal diet, baths and massage, elevation above the sea (and sea voyages), all these, as we have seen, promote a state of 'polycythæmia.' Medicinal treatment also usually tends in the same direction. We may then inquire: (1) Is the success obtained in some sanatoria in any way due to the induction of this condition? and (2) is it a point that may legitimately be aimed at?

These are important questions which cannot well be answered without much more research; but I venture to submit that they are worthy of consideration, and that it would be well if the managers of sanatoria would permit the necessary investigation.

Since Essay II was written, Dr. Percy Kidd has called my attention to an interesting paper published by him in the *St. Bartholomew's Hospital Reports* (vol. xxiii. p. 239), 1887, on 'The Association of Pulmonary Tuberculosis with Disease of the Heart.'

He gives brief particulars of twenty-seven *post-mortem* cases met with in making autopsies on five hundred cases of phthisis; also five cases of aneurysm.

His conclusion is much the same as I have arrived at, namely, that 'all diseases of the heart which lead directly or indirectly to passive congestion of the lungs, and thereby to venosity of the blood, afford a certain amount of protection against tubercular affections, but, in the words of Peacock, "this opposition certainly in no degree amounts to an incompatibility."'

The question of the influence of 'polycythæmia' in the cure of the disease does not come up in this paper.

Essay III

THE PRINCIPLES OF SANATORIUM CONSTRUCTION

WITH DIAGRAM

PREPARED BY MR. G. A. BLIGH LIVESAY, F.R.I.B.A.,

Architect

ESSAY III

THE PRINCIPLES OF SANATORIUM CONSTRUCTION

Essentials of sanatorium construction—Site—General plan—Details—General management—Purity of air—Shelter—Sunshine—Subsoil Access—Grounds—Views—Objects of general plan—Limitation of area—Wards and bedrooms—Terraces—Annexe—Exposure to mid-winter sun—Winter garden—Dining hall—Roof garden—The pavilions—Material and furnishing—Bedrooms—Nurses' ward rooms and sanitary towers—Heating—Shelters—Drainage &c.—Paying patients' sanatorium—Mortuary—Laboratory—Museum &c.—Chapel—Home for destitute—Management—Signalling.

We must now consider how the principles of sanatorium treatment laid down in Essay I. can be carried out most conveniently, with special attention to efficiency, comfort, and economy.

The essentials of sanatorium construction may be grouped under the following heads :

I. The Site.
II. The General Plan of the Building.
III. The Details of Construction.
IV. The General Management.

I. The Site

It seems certain that mere climate is of little importance in itself in the situation of a sanatorium, provided it be not hot and damp. It is true that certain regions have advantages and disadvantages. Thus on the mountains, except on the cloudline,

the air is pure, sunshine usually abundant, the soil pure and dry, the temperature, though cold, yet more equable, and in the winter there is generally less wind. Cold often braces up the system, excites appetite, improves assimilation; but, on the other hand, these rigorous climates sometimes bear hardly upon delicate and weakly constitutions, provoke cough, and cause sleeplessness. Again, a warm climate is often depressing, especially when it is also moist, as at Madeira; but it often soothes an irritable cough and tempts an invalid into the open air. On the whole we may conclude with Léon Petit that climate plays only a secondary *rôle* in the treatment of consumption, and that 'the best climate is that which restricts least the daily duration of the stay in the open air.'

Notwithstanding this, it would be well to search the meteorological tables in order to find a place where the climate is dry, the rainfall small, the degree of humidity of the air low, and the hours of sunshine as many as can usually be obtained in England. The degree of purity of the air, the amount of shelter from strong winds, the nature of the subsoil, the convenience of access, and other matters, are, however, of much more importance, and will have to be inquired into with more care.

1. *Purity of air.*—From what has gone before, it is obvious that pure air is indispensable, and therefore that we must avoid proximity to large towns, or to factories giving forth soot, dust, or deleterious gases. The best places are those in which there is an abundance of ozone in the air, and where the prevailing breezes sweep over the sea, or over moorland or, better still, where these two conditions are associated,

and fresh pure air comes from all quarters of the compass.

2. *Shelter from strong winds* and *exposure to sunshine* are also needed. Hence, sloping plains, well exposed to the south, or broad valleys, fully open to the sun, are favourable, on condition that they are sheltered by hills or trees from the north, or north-west, or easterly gales. The neighbourhood of a forest of fir trees is likewise very desirable, both as a purifier of the air, and as providing a sheltered walk in the heat of summer, and, in winter and bad weather, protection from the wind.

An ideal site in this respect would be a sort of alpine clearing in a sloping pine wood, placed upon the south side of a hill, with a steep declivity immediately below the site.

3. *Subsoil.*—Of at least equal importance is the subsoil.

The now acknowledged partial exemption of dry sandy subsoils from phthisis surely points out the fitting site of an institution for its cure. Whatever may be the subsidiary advantages of such a foundation, it seems certain that the atmosphere over such ground is purer and more free from organic vapours arising with the ground air. It has been proved also that the aqueous vapour condensed from the ground air will favour the growth, even at ordinary temperatures, of the bacillus of tubercle. The purity of the air within and surrounding a sanatorium depends, therefore, to some extent on the nature of the subsoil, and I accordingly venture to suggest that as much as possible *the site should be on virgin soil*—and not alluvial. An uncultivated, non-manured plot, such as

an old moorland or a clearing in a pine forest, is better for our purpose than cultivated or made ground, which is sure to be heavily charged with organic impurities of animal origin. The air arising from the latter kind of ground is more likely to contain, or to favour the growth of, pathogenic organisms. Even under the best conditions, however, the whole site would have to be thoroughly well drained in order to prevent damp from rising into the air.

4. The *access* to a sanatorium should be as easy as possible. It should not, therefore, be too far from a railway station. The roads in the neighbourhood should be in good order, and should be so screened from the buildings that but little dust reaches the latter.

5. *The grounds* should be of considerable extent, not less than 100 acres for an institution of a hundred beds. It is not desirable that the patients should leave the grounds, and space must be allowed for measured walks.

6. Lastly, the *view* from the institution and from its grounds should be extensive and interesting and varied. A phthisical patient needs something to take him 'out of himself.' An extensive and beautiful view exercises an influence upon both mind and body that is most beneficial.

II. General Plan

We may assume that the site chosen for the sanatorium accords with the conditions which I have laid down : that it is on the southern slope of rising ground, and sheltered by the hill behind, by fir trees, or other means from strong winds ; that it is on sandy or porous

subsoil, that it is well drained, and has a cheerful outlook.

The arrangements and methods of construction of the buildings on this site must then be such as to attain the following objects :

1. They must secure the free circulation of pure air in and around all the buildings, especially the wards and bedrooms. The patients' rooms should not, therefore, be arranged in long uninterrupted rows ; and the pavilions containing them should not be more than two stories in height, slightly raised on arches above the concrete foundations.

2. All the patients' bedrooms must be placed within easy reach, under covered ways, of the dining hall and the administration. This proviso is in order that the patients in the most distant rooms shall not have far to walk to their meals or to the doctors' rooms, and also in order that the nursing and medical attendance shall thereby be facilitated.

3. The winter sun, during all the available hours of sunshine, must be able to reach every living room, and hence they must all face S., S.S.E., or S.S.W., and there must be no intervening buildings or trees to cut off any rays from the winter sun.

4. The views of the scenery from all these rooms must also be uninterrupted.

5. All parts of the buildings, from roofs to foundations, should be readily cleansed ; no dust should be allowed to accumulate or to rise into the air in the rooms, and as little as possible in the grounds.

6. The kitchen department must be thoroughly well organised, and must be so arranged that the smell of cooking shall not be perceptible from the living

rooms. A good kitchen garden and a model farm must be formed in the grounds at some distance from the sanatorium.

7. Ample means of disinfecting and cleansing clothes and rooms must be provided, and cloak and linen rooms, as well as sanitary annexes, with bath-rooms and lavatories.

8. Lighting and heating of the rooms should be accomplished, as much as possible, by electricity; and a generating station for this purpose must, therefore, be established somewhere in the grounds, together with a laundry, at a distance from the main buildings.

9. Some arrangements should be made for the reception of dying or far advanced cases in the immediate neighbourhood; and a mortuary, a laboratory, and an 'open-air chapel' must be provided.

10. An operating room and small ward, for surgical cases, must be placed in the administration building.

11. Rooms for the medical staff, for matron, nurses, and domestics, will also be provided in this building.

LIMITATION OF AREA.—If a large number of patients have to be provided for, I would suggest that, in order not to extend the establishment over too large an area, (1) a certain number of them should be housed in wards of from three to five beds each; and (2) that an annexe containing about twenty beds should be placed on a lower terrace, below the main building.

1. *Wards and Bedrooms.*—A combination of wards and bedrooms is desirable in an institution intended for the poorer class of patients. Such an arrangement not only brings the building within

narrower limits, and thus facilitates treatment and management, but it also permits of greater discrimination being made between the different sets of patients.

Well-to-do people are accustomed to separate rooms, and should have them. Certain of the other patients would also be better alone; those, for instance, in whom cough is troublesome, or in whom fever runs high, or who are of an excitable nature; but there will remain a large number of persons who would be happier in company with others of their own station, and to whom such association would not only be no detriment but would be actually beneficial by keeping them bright and in good spirits.

On all these grounds, therefore, it would be well to make the plans so as to include both a large proportion of separate rooms, and also small wards to contain from two to five or six persons.

2. *Building on two terraces.*—By the plan of erecting the buildings of the sanatorium upon two terraces, at different levels, many advantages are secured, and the disadvantages of long uninterrupted rows of rooms are avoided.

On an upper terrace would be placed the chief blocks of buildings, the administration block in the centre, and pavilions, containing wards and bedrooms, on each side of it. But at some distance from this upper terrace, and at a lower level, there could with advantage be placed an 'annexe,' with a dining hall and winter garden, in the centre, and separate pavilions, with more wards and bedrooms, on either side.

By this means the first four conditions of construction are complied with: (1) free circulation of air;

(2) easy access from wards and bedrooms to and from the administration buildings; (3) no obstruction of winter sunlight, or (4) of view.

Medical treatment and nursing would be much facilitated. The rest cure of many of the patients would be more easily carried out, and the whole management of the institution would be more economical of time, labour, and money. The importance of easy access between the administration building and the patients' rooms is readily seen when we consider that the physician visits each patient three times daily, and that most of the patients have to traverse the distance from their rooms to the dining hall and back three times in the day, making a total of six journeys altogether.

It would not be difficult to carry out these suggestions on almost any site. It has been assumed that the selected site lies sloping towards the south; but if it does not so slope naturally, it would probably be quite easy to form the two terraces by digging out the lower portions and carrying the earth to the upper northern side. In any case, even on level ground, the upper buildings could be erected upon a basement story, which would be useful for storage and other purposes.

The upper and northern terrace would be the most extensive, and the pavilions on each side of the administrative block could be made to accommodate forty patients each—eighty in all. I would suggest, in accordance with the remarks above made, that a ward for five patients should be placed at the distal end, on both stories, and another, also on each story, for three patients each, at the near ends of the pavilions. Between these wards would be the separate bedrooms,

twelve in number, making up the required number of beds.

If it were considered desirable that each patient should have a separate room, it would be necessary to have two pavilions on each side with twenty bedrooms in each, ten on each floor, and a short covered corridor between them, so as to avoid the objectionable long rows of uninterrupted buildings.

The Annexe.—The southern building, or annexe, would be at about fifteen feet lower level than the northern terrace, and its pavilions would be over 100 feet distant from it, thus giving a slope of not more than one in eight.

At this level, in the centre, would be placed a large dining hall, close to the upper terrace, with a covered corridor leading due south from it to a winter garden, and on either side of this would be a one-storied pavilion, for ten patients, in wards and separate bedrooms, as in the upper pavilions.

By the plan of an annexe on a lower level we avoid all the objections to the so-called X plan of the building, and retain all the advantages of lessened area, and consequent easy access from the administration building to all parts of the sanatorium.

Ample spaces, for free cross-ventilation, are left between all the blocks of buildings. In this manner provision is made for the circulation of air around and through the groups of buildings, and yet shelter could be had when required. (Note the arrows, showing cross-ventilation, in figs. I. and II. of the diagram.)

One great advantage of this plan is its elasticity. If the conformation and extent of the ground allow, both the northern and southern pavilions might be

extended without interfering with the view or with the winter sunshine. If, on the other hand, fewer patients have to be accommodated at first, the lower pavilions need not be erected until they are required, or they could be made to receive a higher class of patients. Again, deflections from the straight line in each of the sets of pavilions could be made, so as to afford increased shelter to the balconies, and at the same time give wider views to those persons inhabiting the upper buildings.

By means of the combination of small wards and of a one-story annexe, below the level of the northern building, the linear extent of the sanatorium is greatly contracted, and the patients, even in the most distant rooms, are brought within easy distance of the administration. In the suggested plans the total length of the corridor, from the central hall to the extremity of the pavilion, is less than ninety yards, and, as each pavilion is only 200 feet in length, air currents can freely circulate around the buildings. There is no interference with winter sunlight or view.

PLANS.—Elaborate plans embodying all these suggestions have been prepared by Mr. G. A. Bligh Livesay, F.R.I.B.A., of Bournemouth, but only a rough diagram is here appended. The outlines of the plans for the buildings on the upper terrace are given separately from those of the annexe, the winter garden and dining hall, in order to make it quite clear that the upper buildings are exposed uninterruptedly to the winter sun and that there is nothing to interrupt the view. The flat roof of the dining hall is, however, given, in order that the connection between the two terraces may be made plain.

Fig. III. is a section through the main centre line.

It shows the relation of the terraces to one another, the arrangement on the upper one of the administration building, and on the lower of the dining hall, winter garden, and the annexe.

The slope of the site is thus shown to be slight, only 1 in 8, yet it is sufficient to allow the winter sun to shine upon the dining hall, winter garden, and all the wards and bedrooms devoted to the patients.

A few of the details of Mr. Livesay's plans are given upon the diagram, such as the situation of the doctors' rooms, operating theatre and wards, X-ray room, consulting and waiting rooms, kitchen and offices, matron's room and library, staircases and lifts. Two only of the latter are needed, one in the staircase hall, and one from the service room to the dining hall and cellar.

It will be unnecessary to dilate upon these arrangements, but a few words must be said on certain details in the construction of the pavilions, devised to meet some of the other conditions which have been mentioned.

Details of General Plan.—It will be noted that the northern pavilions are built facing south, on the whole, but with a slight deviation in their centres, so as to include an obtuse angle of about 160°, causing the rooms to face slightly to the east or west of south. This is done (1) in order to provide more protection from strong winds on the balconies, (2) to extend the views and especially to avoid seeing even the roofs of the lower pavilions, (3) to enable the architect to place a nurse's room or ward kitchen at the angle, and from this room, by means of slight projections, into the

corridor and balcony respectively, she is able to look along both these passages, to secure efficient supervision of the patients, and to be notified, by signal or otherwise, of their requirements.

The southern pavilions are also turned at a slight angle towards the central line to give increased shelter to the balconies, and in order that the dining hall and upper terrace may catch all the available sunshine in mid-winter. They are therefore also placed at a certain distance from the dining hall.

On the shortest day, in the latitude of Southern England, the altitude of the sun at midday is only 16°. It rises about 8 A.M., and at 9 A.M. is only 6° above the horizon; but, owing to the deflection above mentioned, the lower buildings do not intervene between it and the dining hall. By 10 A.M. it has risen to an altitude of about 11°, and, although the end ward now casts a shadow towards the dining hall, the luminous rays pass over the roof of this building, and shine directly into the hall. They continue to do so, in fact, so long as the sun is visible above the horizon. These facts are indicated by the dotted lines and Roman numerals on the diagram (figs. III. and IV.)

Owing to the higher level of the upper terrace, all the wards and bedrooms in the upper pavilions, and all the south rooms in the administration block, are at all hours fully exposed to every ray of available sunshine.

I have been thus particular in arranging that every room occupied or visited by patients should be flooded by sunlight whenever possible, because, of all disinfectants, sunlight has been shown to be the most powerful. It is perhaps, together with pure air, the only certain non-liquid disinfectant for the tubercle

bacillus. Hence the importance of our arrangements for securing that every corner of these rooms should have this beneficent 'search-light' turned upon it at some time or other.

Placed as it is on the same level and on the northern side of the winter garden and the lower pavilions, the dining hall is the only portion of the sanatorium frequented by the patients that might appear to be in danger of a shadow being cast upon it, but, by the devices which have been mentioned, even this room receives all the year round almost every ray of available sunlight. The sills of the windows on the southerly sides of this room are kept as low as possible for the same reason. The sloping gangway from the roof of the winter garden is the only impediment to the sun's light reaching the dining hall, and that only for a few minutes in each day.

The Winter Garden.—The central portion of the lower terrace is occupied by a winter garden, which is intended to be a place mainly for social meeting and for recreation, under shelter but almost in the open air. It is ovoid in form; is about 60 ft. in length, 40 in breadth, and 14 ft. high. In addition to its projecting roof, it is protected on all sides except the front by glass screens, to be opened on the sides away from the wind. It has also a large central 'lantern' top-light, provided with ventilating electric fans.

It is not a conservatory, but a few palms and other plants may with advantage be placed in it. A sufficient number of couches, chairs, tables, &c., are provided, and a small movable stage or platform would be available, when required, for concerts, variety entertainments, &c.

. Its roof is flat, except round the edges, which are of sloping glass, and a large portion of it can be arranged as a lounge, surrounded by ornamental railings; a gangway would then lead from it to the flat roof over the dining hall.

The Dining Hall.—To the north of the winter garden, on the same level and 60 ft. from it, stands the large dining hall. (70 × 40 × 16 ft.)

It rises two feet higher than the winter garden, and, as we have said, it has also a flat roof.

It is ventilated at the top by a small 'lantern,' with electric fans, as well as by its windows, which surround it on three sides and which reach from the ground to the ceiling. The sunlight will therefore reach all over it. All corners are rounded off, to prevent the accumulation of dust.

A lift from the staircase hall in the administration building conveys infirm patients from and to the upper level. There is also a service lift on its north-eastern side leading to the service rooms and to the kitchen.

Roof Garden and Restaurant.—On the flat roofs of the dining hall and winter garden are, as we have seen, two open spaces, connected by a gangway. As it has not been considered desirable to provide an indoor withdrawing room (see Essay I., p. 33), these open spaces could be used as a restaurant, lounge, or place for meeting, and, in suitable weather, for all kinds of *al fresco* entertainments. They could be covered, when required, with awnings.

The Pavilions.—The pavilions, as we have seen, are four in number, and, except that those on the upper terrace are two stories in height and those of

the Annexe are only one, they are similar in design, and possess both wards and bedrooms.

The upper pavilions have corridors on the northern side, running from the administration building to the wards at their further ends.

On the ground floor these corridors are 10 ft. wide, in order to permit of exercise in bad weather and to afford shelter from the sun on hot summer days. On the first floor they are only 6 ft. wide. They are open except for the roof, balustrades, and sliding glass screens.

In front of each pavilion also there are balconies, 8 ft. in width on the ground floor, 7 ft. on the first floor; on to these, reclining chairs may be wheeled when required.

Although the first floor balconies are 7 ft. wide, it is not considered desirable that the rooms below them should be overshadowed to this extent. Accordingly, by a steplike arrangement (shown in Fig. IV.), the bedrooms on the upper floor are set back to the extent of 4 ft. The lower verandah is thus only covered by 3 ft. of the width of the balcony above, and no shadow is cast in winter on to the floor of the lower bedrooms. The covering roofs of the upper balconies also project only to the extent of 2 ft. In each such roof, however, is attached an awning on rollers, which can be extended over the balcony when the strength of the sunshine makes its shade desirable. The architect assures me that there would be no lack of stability in this mode of construction, as steel girders have to be used in any case across the building where fireproof floors are specified.

III. Details of Material and Construction

Foundations.—The whole ground having been well drained with subsoil drainage by open pipes, the foundation of the buildings is laid in a bed of concrete, well rammed, 6 inches thick, with a layer of good asphalte over the whole area.

Upon this is raised a series of arches about 3 or 4 ft. high, so that the whole space can be flushed out, when required, to cleanse away fine dust, &c. Larger *débris*, flies, and other vermin are kept out by wire gauze, which is constantly kept in good order.

Under the dining hall, winter garden, and administration block the different levels are connected by broad flues, to permit of access to the whole area and free perflation of air. Through these 'flues' are carried the steam or hot-water pipes, electric wires, &c.

Materials and Furnishing.—The winter garden is constructed entirely of iron and glass, with the exception of its floor and flat concrete roof.

The dining hall and administration buildings are built mainly of brick, iron, glass, and concrete. The latter is roofed with tiles, and their floors are mosaic or are made of some hard wood, preferably teak, which can be periodically waxed or paraffined.

The dining hall may be furnished with hard-wood tables each about 25 ft. long, and with un-upholstered 'bent-wood' chairs.

The pavilions also are constructed mainly of brick, iron, glass, and concrete, and are roofed with tiles; the corridors are almost entirely of iron and glass, with mosaic or hard-wood floors.

The floors of the bedrooms are of mosaic or hard wood. The walls of all the rooms are covered with hard, polished, coloured cement (Keene's), all the corners are rounded, no ledges being left for the collection of dust. The electric wires are embedded in the walls, with casing covers, flush with the wall face.

Bedrooms.—The bedrooms are all 16 ft. × 10 ft. × 11 ft., and thus have a cubic capacity of over 1,700 ft. The wards vary in size, and contain three, four, or five beds, but they are all of ample cubic capacity.

The southern fronts of all the wards are arranged in the form of a bay window, so as to catch the rays of the rising and the setting sun. The doors of the bedrooms are placed close to one of the walls. They are $7\frac{1}{2}$ ft. in height, with openable, swinging fanlights above, the whole width of the rooms, and reaching to the ceiling. The fanlights can only be closed or opened from the corridor. The object of this arrangement is to prevent any stagnation of air near the ceilings. The windows of the (pavilion) bedrooms are $7\frac{1}{2}$ ft. high and 5 ft. in width, with two large panes, which slide within the walls or which swing out on to the balconies. They are framed in gunmetal or brass, and are hung on ball-bearing rollers to prevent rattling or jambing. They have very low rounded sills in order to permit the bed or couch to roll over them. The windows are shut only on rare occasions. Above them are four glass fanlights, the whole breadth of the front wall, reaching to and opening inwards towards the ceiling, by means of levers worked from the balconies. Neither these nor the windows are under the control of the patients, but only under that of the doctor or

nurse. There are louvred shutters outside the windows, which fold in two parts back to the wall. In order to overcome the difficulty which prevents patients from enjoying the full benefit of the open air at nighttime, Dr. Hort, of San Remo, has devised the following plan for suitable cases, and kindly allows me to mention it. It has been used successfully for the last three years, and has proved better than doorless and windowless rooms, or sleeping in tents, kiosks, &c. It has the merit of simplicity, and I venture to describe it here. 'The only essentials to its complete success,' he says, 'are intelligent supervision in working shutters or awnings, and care, on the part of the nurse, to provide sufficient night clothing and other accessories for warmth in cold weather. In the cases deemed suitable, the louvred shutters are placed at right angles to the line of the building, the patient's bedhead is pushed out about two feet, on to the balcony, the waterproof roller blinds are pulled down, and the patient then lies with the head outside the window, and yet is in perfect privacy, and sufficiently protected from dew, rain, or snow.'

Each bedroom is provided with electric light, bell calls to the nurse's ward room and to the porter's lodge, and an automatic signal to the nurse, to be described under 'Management,' is also provided.

Hot and cold water is supplied to each room, and the taps are placed over a fixed washbowl, discharging into an open and easily cleaned channel. Through this the 'slops' are conveyed to a trapped and easily cleansed grid in the corridor, and thence to the drains.

The furniture consists of an iron bedstead of bicycle frame tubing with telescopic adjustment to form

a bed-rest (Kirkland's), a wardrobe with sloping top, and no ledges, a chest of drawers, a 'commode,' two chairs, one of them a reclining chair, a Pratt's combined chair, bed-table, and locker, with chart-rack and towel rail, and a removable strip of carpet, or, better still, of washable cotton bath matting. All the heavy pieces of furniture run upon rubber-tired, ball-bearing castors, to obviate noise and to allow of easy movement. It is probably best that urine and other waste should be removed from the rooms in the ordinary manner, to be disposed of in the housemaid's closets, the utensils being finally scalded and treated with some safe disinfectant. A tray-bath might also be sunk in the floor, in front of the wash-bowl. It would have a hinged cover let in flush with the floor. It would discharge by a waste pipe into the channel before mentioned.

Fig. IV. is a section of one of the upper pavilions, with its two stories, corridor, and balconies. It will be noted from this, fig. IV., that the corridors have double roofs, in order to leave a space which is always open to the air, allowing constant cross-ventilation through the upper part of the rooms. This area is useful for carrying steam pipes, hot and cold water supply, electric wires for light, bells, &c., and waste pipes. It allows repairs or cleaning to be carried on, without interfering with the thoroughfare of the corridors. Fig. V. is a section through one of the bedrooms of the Annexe.

The Nurses' Ward Rooms and the Sanitary Towers. It will be seen from the general plans (figs. I., II.) that six rooms in the pavilion are assigned to nurses. They are placed at the 'bend' of each pavilion.

They are not intended to be used as bedrooms, but are chiefly useful as offices and kitchens for both day and night nurses. They have each a door and window looking into the corridor, and project slightly into these passages, so as to allow the nurses to look along them, thus facilitating the necessary surveillance. They also have windows on the balconies, every part of which can be seen from them.

The sanitary towers are octagonal in form (see Plan I.) in order (1) to have as few right angles as possible, (2) so as not to impede the free passage of air round them, and (3) to admit of ventilation from all quarters of the compass.

The sanitary towers are situated on the northern side of each corridor, immediately opposite to the nurses' ward rooms. They are separated from them by the width of the corridor, and by a short T-shaped open gallery, six feet in width, leading to the towers.

Each tower has on both stories a bath room, containing two baths, partitioned off from one another, four w.c.'s, and a housemaid's closet. A sanitary cupboard is placed in each housemaid's closet. These conveniences are built out on corbels to form a right-angled projection, and are cross-ventilated by means of terra-cotta gratings. They are lined with glazed tiles, and are entirely shut off from the interior by close-fitting iron doors. They are intended to receive labelled specimens reserved by the nurses for inspection and examination by the doctors.

Heating.—The heating of the establishment may be accomplished for the most part by electrical radiation

or by a system of high-pressure steam pipes, similar to that used at the Royal Derbyshire Infirmary, which, though costly, is certainly very efficient.

The heating of the administration block, halls, corridors, operating room, dining hall, and winter garden is effected by steam. The kitchen department, board room, and nurses' rooms are provided with open fireplaces.

The steam pipes are carried from the central building along each pavilion corridor, next to the bedrooms, in the spaces under their floors. There they are easily reached and cleaned, and can be repaired.

A branch is supplied to each room, passing in near the door just above the curved skirting. They are left bare to permit of daily wiping over with some disinfectant. The radiators are coils of copper piping, which can be enclosed in a cupboard, flush with the wall, which, when open, permits the whole apparatus to project into the room, where it also could be wiped over daily.

These radiators work noiselessly and efficiently, but, in order to provide for occasional defects or a breakdown in the system, in all the twenty-four bedrooms in the upper (northern) pavilions an open fireplace is provided, in the near corner of each room, as shown in the plan. One chimney stack suffices for four bedrooms, six to each pavilion. These fireplaces would be very seldom used, and are made as simple 'hearths,' to burn wood or anthracite coal, so that little smoke would arise from them on the rare occasions of their use. They can be closed by an iron cover, and the whole room can be sluiced out periodically by a two-inch fire hydrant.

We may mention incidentally that these hydrants

would not be needed to put out fires (excepting perhaps of bedding), as the architect guarantees that all the buildings are absolutely 'fireproof.'

Shelters.—For the reasons already given, extensive provision of galleries or *Liege-halle* has not been deemed desirable.

Whenever possible, patients should recline on their *chaises longues* in some sunny, but sheltered spot in the open grounds. When the day is showery, a kind of open tent with a screen to the windward could be placed over the reclining chair, and waterproof wraps placed over the limbs.

In stormy weather more complete shelter is necessary, and huts of the pattern designed by Dr. Denton Johns may be used. These are square or hexagonal in shape, ventilated at the ridge of the roof and under the eaves. They have shutters or windows all round, any of which can be lowered like a carriage window to the leeward. They are large enough to receive two or three patients, and about a score of these erections, dotted about the more exposed parts of the grounds, would be found useful.

Another convenient pattern is the simple open shed which revolves easily on a platform, and may thus be turned away from the wind.

Many patients will find shelter on their balconies, with their waterproof roller-blinds drawn partially down, and with the louvred shutters so arranged as to protect them from the wind.

It is not desirable, however, that more than any two of the adjoining balconies should be left free for communication, and a hinged and padlocked gate is therefore provided between each.

Drainage and Disposal of Refuse.—It is scarcely necessary to say that the drains are all outside the buildings, and that they are cut off from them by open channels, and, in the case of the water-closets, by ample ventilating shafts reaching well above the ridges of the roofs.

It would also be well to have the comparatively clean water drains, from the baths, rain-water pipes, &c., separate from the soil and slop drains; and, by means of a Field's siphon tank or a tumbling cistern, this water might be made to flush automatically the soil drains.

Ultimately, the whole drainage is disposed of by bacterial beds and intermittent downward filtration.

The best method of finally disposing of the sputum is still *sub judice*. Undoubtedly the most certain plan is to burn it in a destructor, but it is difficult to prevent nuisance from the smell that is apt to arise from it into the atmosphere. Possibly the addition of a 'fume destructor' to the apparatus would obviate this evil.

In most institutions of the kind the contents of spittoons, flasks, &c., are washed down the drains; often into cesspools, and, so far as we know, no harm has come of this proceeding; but it certainly seems desirable that careful inquiries should be made to determine whether the tubercle bacillus can escape destruction in the 'bacterial' tanks or during intermittent downward filtration.

The following buildings are better detached from the general sanatorium:—

1. A sanatorium for twelve paying patients, containing also rooms for the Superintending Physician

(unless it is thought better to give him a separate house). The Annexe might be utilised for this purpose.

2. A mortuary, laboratory, and museum, under one roof, some distance away from the other buildings.

3. A laundry and dynamo shop, which might be placed near the farm. It would be convenient to have a light tramway from this place to the central building.

4. Entrance lodge and stables.

5. A chapel will be needed for the persons employed about the establishment. It is not desirable that the patients should congregate in this edifice. Open-air services should be instituted for their benefit. The chapel might be placed opposite the porch of the main building; or, better still, a large open kiosk in this situation might have attached to it a small chancel consecrated for the purpose, which might be used for the sacraments.

6. It is important that an asylum should be found in some other detached house near at hand for destitute patients, who are not doing well in the institution, who are too ill to be removed to a distance, or who have no home except the workhouse. Such cases, if allowed to remain, would be very detrimental to the other patients, and yet it is very painful to be obliged to send them to the pauper hospital.

N.B.—No plans are given of these minor buildings, as they would naturally be of simple character.

IV. Management

The supreme control of the sanatorium must be given to the Chief Medical Officer, who would have

assistance in its management from a general manager or secretary, to whom he could delegate most of the work of supply, control of men-servants, correspondence, &c.

His staff would consist of two assistant physicians, one of whom would reside in the main building. He would himself have a private residence in the grounds.

A matron and about ten nurses would usually be required, and would be quartered in the administration building. Of these, one is assigned in the daytime to each corridor (six in all). At night probably one night nurse will suffice for each pavilion.

Four bath attendants, two male and two female, are required for the bath rooms, and for attendance, at certain hours, in the bedrooms of patients pointed out by the doctor.

The six day nurses would each have charge of from ten to twenty-four patients, and would help them at meal times, under the superintendence of one of the resident physicians. They are taught how to use the lift, and would personally conduct the more delicate patients.

Most of the meals would be taken in the dining hall or on the upper terrace. The more serious invalids would be served in their rooms, balconies, or shelters.

The matron over the nurses would also, perhaps, be able to overlook and manage the domestic servants, whose number would be determined by her. Probably six maids, four wardmaids, and two charwomen would be sufficient; one maid to each pavilion, and four housemaids in the administration building. They would thoroughly clean every room once a fortnight,

but each bedroom is wiped out daily with damp cloths, dipped in some safe disinfecting solution.

The cook and his, or her, two or three assistants are most important members of the household, and should be highly skilled in the preparation of all the foods required.

Besides the above-mentioned servants, there are needed a porter, with assistant, stoker, electric manager, farm servants, ambulance driver and groom, gardeners, labourers, laundresses, and others. A cook, scullerymaid, and two housemaids would suffice for the sanatorium for paying patients.

Most of the utensils required for the patients' use are best made of enamelled iron, and they should be plunged, together with forks and spoons, into a tank of boiling water immediately after use.

Paper handkerchiefs and table napkins are to be burnt at once. The æsthetic influence of clean table-linen should not be ignored; but it may be observed that, at some sanatoria, white or coloured American cloth is used.

Light carts or 'trollies' with rubber tires are required to convey food and other articles to and from the bedrooms.

Rubber or felt-soled shoes are worn by every one in the establishment, in order to prevent noise in the passages, corridors, and rooms.

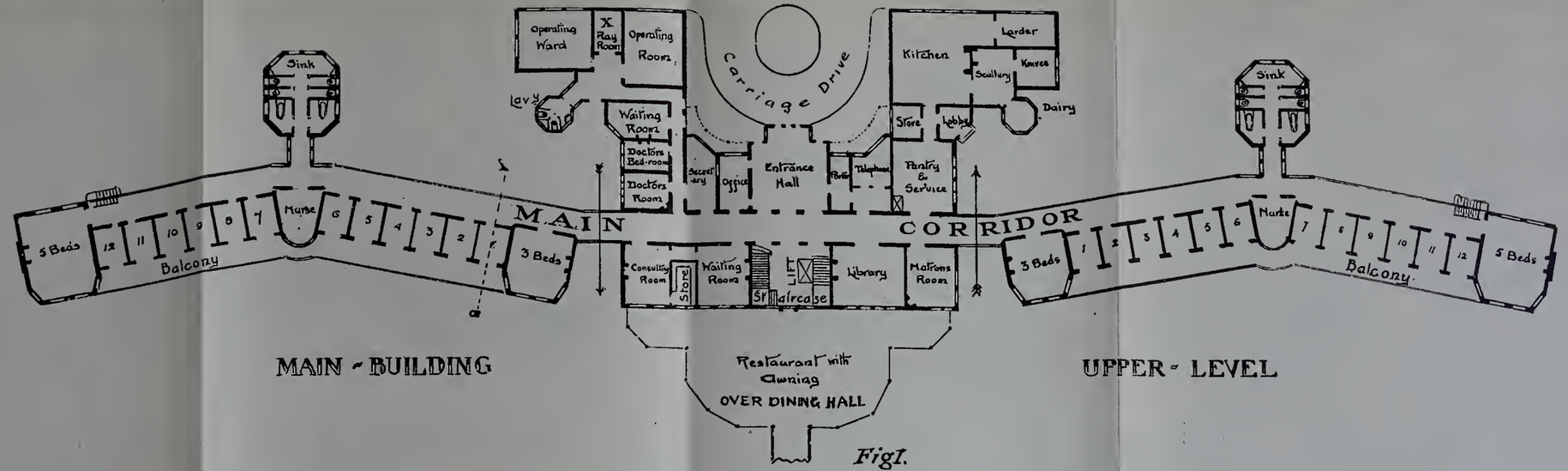
The clothing of the patients must be, as before said (Essay I., p. 31), warm and kept clean, and must meet with the approbation of the medical officers. Additional wraps and waterproofing are kept for lending out under the charge of the nurses, who also keep the outdoor boots and shoes.

Friends are allowed to visit some of the patients, but for short periods only.

The duration of stay in the institution is not fixed, but is left almost entirely to the discretion of the medical officer in charge.

Seeing that the pavilions are not like ordinary hospital wards, and that the nurses are not always in view, a careful system of 'signalling' is devised. When the nurses' bell is sounded, it also automatically hangs out a numbered red flag on the balcony opposite the room. The nurse in charge, on hearing the ward-room bell, at once looks out from any room she may be in, along the balcony, and goes to the room indicated. At night the number is illuminated by an electric light.

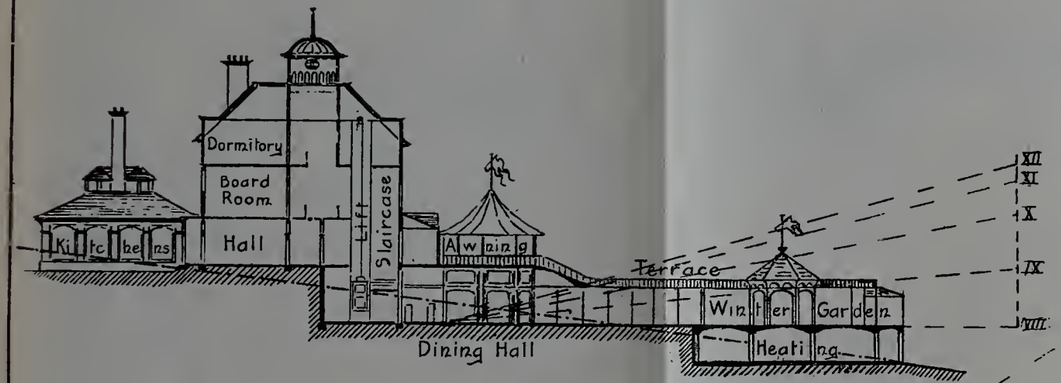
Note: The arrows indicate cross-ventilation



MAIN - BUILDING

UPPER - LEVEL

Fig I.



MAIN SECTION.

Fig III.

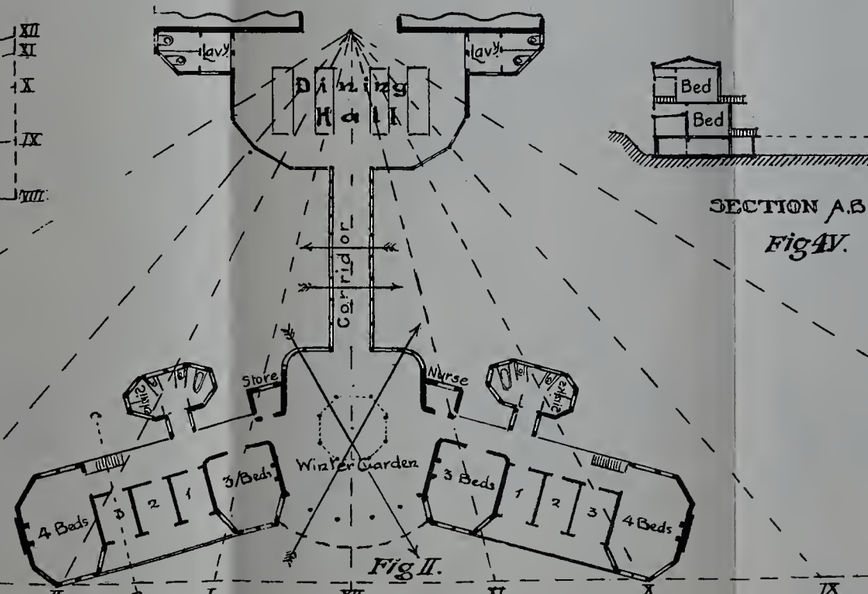
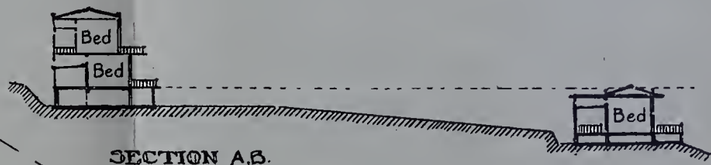


Fig II.

ANNEX

LOWER - LEVEL

SCALE OF FEET 50 40 30 20 10 0 50 100 150 200 250



SECTION A.B.

Fig IV.

SECTION C.D

Fig V.

Note: The Roman Numerals indicate the deviation — and altitude of the sun at certain hours of the day

PLANS AND SECTIONS FOR A SANATORIUM.

G. A. Pilch. Liverpool F.R.I.B.A.
Architect, Bournemouth.

Essay IV

ON THE PURE-AIR TREATMENT OF PHTHISIS AT HOME

ESSAY IV

ON THE PURE-AIR TREATMENT OF PHTHISIS AT HOME

Patients requiring home treatment—Climate—The house, furniture, &c. —Sleeping huts—Aseptic treatment—Rest—Exercise—Feeding—Power of resistance—Prevention and treatment of accidents—Suitable amusements.

MANY papers have been written giving high praise to the sanatorium treatment of phthisis, and, in my opinion, these laudatory notices have been fully justified by the results. These institutions for the 'open-air' treatment have, in truth, many advantages. They are expressly adapted for their purpose; with all the needful appliances, shelters, galleries, or verandahs, and their windows open fully to the ceiling of the rooms. Most of them are newly erected upon healthy sites, on dry, pure, and porous subsoils; they are appointed and furnished with a view to the avoidance of dust, and hence they have a minimum of microbic impurity in the air. Special attention is paid to the food of the patients, and systematic supervision is kept up by both nurses and doctors. The example of the inmates, and their general well-doing, make it easy to carry out the otherwise unpleasant discipline, and in most of these places there is an air of general contentment. All these circumstances render the treatment in sanatoria more perfect than it can be in most private houses.

But there are many persons who cannot or will not be treated in sanatoria. There are fathers and mothers whose cure would be greatly interfered with if they were separated from their children ; sons and daughters who are unwilling to leave their parents ; delicate persons who shrink from the public life of a sanatorium, or even of a nursing home. There are also large numbers of persons who, having been 'greatly improved' by a residence of from three to six months in sanatoria, are yet susceptible to reinfection, and who must, for many months, continue to pursue the open-air treatment at home. Add to these the many patients who, owing to the present deficient accommodation, are unable for many months to obtain an entrance to any well-equipped institution ; all these persons need efficient open-air treatment, and most of them greatly desire that it should be carried out at home.

Under certain stringent conditions, I think that it is quite possible to do this, and it may be of some service to point out in what ways it may be accomplished.

Climate.—Sanatoria are for the most part placed in carefully sheltered situations, yet fully exposed to the air and sunshine. Our homes are planted wherever the convenience of the chief inmates is best served. Only in the case of the rich, or of those who have entirely retired from all kinds of business, is the healthiness of the site the chief object in view. Can we then neglect entirely the circumstance of climate and site, and at once attempt to begin our treatment at any home? I think that most of us would answer this question in the negative.

Our views in regard to climate have indeed undergone considerable modification in recent years. Not long ago our records of cases of cured phthisis would chiefly have included the names of those favoured persons who had been able to go to Egypt, the Riviera, or to some other fashionable health resort; and a medical man who neglected to recommend to a consumptive some such place would have been regarded as entirely wanting in medical knowledge. Since this time a distinct change has come over the opinions of most medical men. Some now regard the question of climate as of quite secondary importance; others, 'that the favourable influence pertains to the change, rather than to the particular climate chosen' (Austin Flint); others, again, limit the advantages of climate to the opportunities for comfort, exposure to air and sunshine, for good feeding, and for a total change of the habits of life. The number of those who take extreme views in regard to climate is, however, fortunately small.

Although it may be acknowledged that phthisis occurs in all climates, and that cures of the disease also occur occasionally under the most adverse meteorological conditions, it yet cannot be admitted that all climates are equally suited to its open-air treatment. In the first place, we have to remember that, for the open-air treatment, abundance of sunshine and a perfectly pure atmosphere must be sought for; hence all places on low-lying, damp, impure subsoils are unsuitable. In the next place, the patients we have to deal with are, for the most part, delicate, tender beings, who have to be carefully guarded at the outset from the sensation and even from the idea of draughts.

After a few weeks of treatment they usually become inured to much stronger currents of air than they can bear at first; but, owing to the initial delicacy, they require shelter from strong winds.

Any homes, therefore, in which the treatment is to be carried out should be protected from strong winds, and especially from strong sea breezes. They should never be close to the seashore. We may add to these requirements the importance of a low degree of humidity and a small rainfall, and, though not strictly connected with climate, we may put in a plea for some æsthetic advantages.

It is of great importance that a patient's mind should be kept bright and cheerful by pleasant surroundings, and we might even put in a plea for euthanasia in hopeless cases. As a patient once said to Dr. Walshe, with reference to Madeira: 'I know I go there to die, but to die amid the glories of beautiful Nature, cradled in an atmosphere as balmy, as redolent of flowers, as its sun is glorious. Here, too, I should die, but die cribbed and confined in a room, narrow as sunless, smoky, foggy, cheerless.'

It will thus be seen that the climate, or perhaps rather the locality, in which the home is situated cannot be neglected in considering its fitness for home treatment. Let us suppose, however, that the home is placed in a perfectly desirable locality; that it is sheltered from strong winds; that it is somewhat raised above the level of the surrounding country; that the air is dry and pure, and not polluted from any source, especially by manufactures, by human or animal emanations, manured fields, &c.; that the subsoil is dry and pure, and well drained; and, lastly, that its outlook is

not too uninteresting, and that there are the means of simple amusements in its immediate vicinity.

The House.—Notwithstanding all these advantages, before we decide that the residence is entirely suitable, we have to ask whether this house is the same as that in which the patient lived before the open-air treatment was adopted.

I have elsewhere expressed my conviction that many of the cases of cure of phthisis, supposed to be due to change of climate, were really due simply to change of residence. In an old house it is well known that there is a great excess of microbic life floating about in the atmosphere; and in a house that has been inhabited for some time by a phthisical patient there are probably lurking in some dark corner active colonies of the bacillus of tubercle, nourished by the organic vapours of the house, and ready to float into the atmosphere, and to settle in the susceptible lungs into which they may be breathed.

A consumptive person has already proved himself to be vulnerable by the specific microbe, and his damaged lungs must present many suitable nests in which it can incubate and start a fresh attack of the disease. On account of the danger of reinfection, therefore, it is most desirable that, before commencing the new method of treatment, the patient should change into a new house, or else that the old one should undergo renovation from top to bottom, and that all surfaces should be well brushed over, after Professor Delépine's method, with a 1 per cent. solution of chloride of lime. In old houses, also, I have been in the habit of recommending a thorough cleansing by atmospheric ozone, which is now easily

carried out. In some cases it would be sufficient to restrict these cleansing and disinfecting operations to the rooms and passages which will be visited by the patient; but in all cases the cellars, if any, should be thoroughly cleansed and ventilated, as impure air from this source is often drawn up into the house. The drainage of the house must also be ascertained to be thoroughly efficient.

The 'shell' of the dwelling being thus rendered so far satisfactory, it will then be necessary to turn our attention to the plenishing and decoration—at any rate, of those portions of the house likely to be visited by the patient. The main object to be kept in view must be the prevention of the formation and the harbouring of dust. The walls should be distempered or covered by washable materials, whether paper or paint; the floors waxed or prepared with paraffin, or, if old, covered with 'cork carpet;' and all angles or insetting corners should be carefully rounded off, so as to prevent any accumulation of dust. There should be no heavy hangings, nor carpets; only strips of matting or drugget, or small mats, which could be daily put out of doors.

The furniture should all be of the simplest pattern consistent with comfort, and should be chosen with a special view to prevent the lodgment of our chief enemy, dust. Hence pictures with projecting frames should be banished, and, if possible, there should be no cornices which cannot be wiped over with a damp cloth. Light and easily cleansed screens should form part of the furniture of each room; and the windows must be made to open widely, and as near the ceiling as possible. Ready means of summoning an attendant

by an electric bell must be provided, and it would be well if some one, whether a servant or a member of the family, could be told off to look after the patient.

In certain cases, in which it would not be practicable to carry out all these directions, the difficulty might be overcome by adopting Dr. Johns's method of erecting a sleeping hut, in which the patient could entirely take up his abode. The important conditions in this arrangement would be that it should be placed on a raised platform, on pure dry soil; and that it should be in a sheltered situation.

INDIVIDUAL TREATMENT.—When our patient has been suitably housed the principles of the treatment to be pursued may be considered. They may, perhaps, be advantageously grouped under the following heads:

1. *Aseptic treatment.*—I trust that it is unnecessary again to insist upon the fact that phthisis is a 'filth disease,' that its specific cause, the tubercle bacillus, is nourished, and retains its virulence, only in presence of organic impurity, especially such impurity as is to be met with in dirty, ill drained, badly lighted, overcrowded tenements. Professor Delépine and I have also shown that it rapidly loses all infective power in pure air and sunlight. These facts explain the first necessity in the treatment of the disease—namely, pure air and abundance of sunshine.

We have seen the arrangements relating to the residence which are deemed necessary in order to secure these requisites, but the patient will have to take measures to prevent the pure home from becoming contaminated by his presence in it. Hence the absolute need for all the well-known precautions with

reference to the disposal, disinfection, and destruction of all bacillary excreta.

There is a further reason, apart from the bacillus itself, for insisting upon a germ-free atmosphere ; that is, the danger to a consumptive of all kinds of septic organisms. It is well known that among the worst and most rapid cases of phthisis are those in which there is a mixed infection, and in which various micrococci assist the tubercle bacillus to gain an entrance to fresh parts of the frame or to intensify its morbid action.

The modern treatment of phthisis is in truth simply a branch of what might be called 'antiseptic or aseptic medicine,' in analogy with 'aseptic surgery.' Just as the surgeon takes the most elaborate care to cleanse his hands, instruments, and dressings from all possible contamination, and wards off from wounds all septic organisms, so must the physician purify the atmosphere surrounding his patient and guard his lungs from all danger of admitting to their recesses any pathogenic organism.

Hence the importance of the adoption of measures directed against all kinds of septic organisms. Fresh air and sunshine have probably some power over these organisms as well as over the tubercle bacillus ; but I believe that the chief natural agent arrayed against them is atmospheric ozone. In such a climate, and in such a situation as I have described, there is usually an abundance of this agent in the air outside the house, and though in an ordinary bedroom with its carpets and upholstery it is scarcely ever present, I have ascertained that it is to be found even in the centre of a room furnished and ventilated as I have described. Notwithstanding this, however, in some cases when the

patient has been confined to his room by fever or hæmorrhage I have thought it well artificially to impregnate the air of the room with ozone.

But the aseptic treatment of phthisis need not be limited to the purification of the atmosphere. It should extend to the body of the patient; hence the need of insistence on baths, washing of hands before meals, clean clothing, &c. There are some practitioners, especially some who profess the open-air method, who entirely neglect the use of drugs; but I venture to assert that they are wrong. Doubtless it is right to relegate these agents to a second place in comparison with pure air and sunshine, but it is impossible to resist the evidence of the good effects of such medicines as creasote and iodoform. These drugs undoubtedly do much good in many cases, and it is highly probable that they do so by their antiseptic power, not necessarily by their power over the bacillus itself, but perhaps by their efficiency in cleansing the intestinal canal, and perhaps by increasing the resistance of the tissues to attacks of the specific microbe. In any case they are often useful, and should not be cast altogether aside.

2. *Rest.*—The importance of rest to the injured organ has so recently been insisted on that it is only necessary to briefly recapitulate its advantages.

(*a*) In repose there is scarcely any motion of the ribs; there is little or no disturbance of the underlying inflamed tissues, and no dragging upon any adhesions which may have been formed between the two layers of the pleura. In the semi-recumbent posture, therefore, on a cane deck chair, is afforded the best chance of subduing inflammation, of preventing cough, and preventing extension of the disease.

(*b*) The continuous warmth of the body during exposure to the open air is better kept up in the recumbent position than in any other.

(*c*) It conduces to gain in body weight. During repose in a semi-recumbent posture digestion is more easily carried on, and absorption and assimilation are better performed. In most cases the patient puts on flesh with more or less rapidity.

(*d*) It greatly assists the blood-making organs, and leads to an increase in the hæmoglobin. One of the results of rest, combined with fresh air, is the speedy improvement in the complexion of our patient.

3. *Graduated exercise.*—Complete rest in bed has its dangers as well as its remedial power. It is acknowledged that in phthisis our aim must be to raise the bodily powers to the highest point we can consistently with safety. This is not possible in absolute rest; hence, as Dr. Walters remarks in his excellent work on Sanatoria (p. 38): 'In all cases [in which it is safe, which he specifies] exercise is needful according to an ascending scale. We may begin with passive motion or very gentle massage, followed by resisted movements in the recumbent position. After this, very gentle walking exercise may be tried, at first restricted to a few yards at a time on level ground. As the invalid gets stronger the length of his walk is gradually increased.'

In Essay I. (p. 27), I have ventured to point out that 'the degree of rest that must be imposed will depend (1) upon the presence or absence of fever, and (2) upon the digestive and assimilative powers. The degree of exercise (1) upon the muscular and

bodily vigour of the patient; (2) upon the extent of movement allowed by the disease to the ribs in forced respiration, and especially to the bones over the site of the injured parts of the lungs.'

4. *Full feeding.*—Careful feeding of our patient can be carried out just as well in a private home as in a sanatorium, and very often his individual tastes can be better consulted. It is important, however, that the amount of food taken should be as methodically ascertained and recorded. It is admitted by all that full feeding is a necessity, but there are various opinions as to 'fattening' our patients. In my opinion it is, in truth, not a question of fattening, but of strengthening our patients. If the fattening gives more power of resistance against the advance of the microbe, which it often does, then the fattening is good; but it is certainly not the mere putting on of adipose tissue which is of importance, but the general increase of bodily vigour by massage and passive exercises, the improvement of the blood, and the general growth of muscular and nerve power.

The method of feeding also must be adapted to each individual. It is absurd to insist upon the procrustean method of applying the same measure to all patients, and the attempt to do so savours too much of quackery, and of the continental mode of turning each special form of treatment into a 'cure.' For many persons doubtless the regulation of three large meat meals a day, with nothing between, may serve a good purpose, but to dragoon everybody into the same line is assuredly not physiological feeding. While there are some who cannot take anything between the three larger repasts, there are others who

are much the better for a tumbler of milk and a biscuit in the interval.

5. *Increase of the power of resistance.*—There is not much to be said on this head. All the means already mentioned may be regarded as tending towards this end, and if we must single out any as especially important towards it, it will be to the feeding and judicious rest and exercise that we must look.

6. *The prevention and treatment of accidents.*—This is of great importance, and needs all the skill and constant attention of the medical attendant. The chief accidents we have to fear are (*a*) perforation, (*b*) hæmorrhage, (*c*) inflammation.

Every patient in whom ulceration is going on, or who has aneurysmal sacs, is exposed to these risks. The first two usually occur without warning, and it might well be supposed that they would be inevitable; yet something may occasionally be done to ward them off. By means of as much rest as is possible to the injured parts, and by the general nourishment of the body, and plentiful supplies of oxygen and ozone, we may often arrest the ulceration, and may minimise the danger of the breaking down of tissue.

In hæmorrhagic cases, by careful dieting we may prevent too heavy a strain being thrown upon the vascular system; and we must limit to the utmost all over-exertion and all forms of excitement. In such cases we should diminish the supply of strong animal foods, and should encourage the use of nourishing vegetable and farinaceous and milk foods, and should limit the amount of fluid to be taken at any one time. It has also been shown that something may be done

to increase the coagulability of the blood by the persistent use of calcium chloride.

Inflammatory attacks usually give some warning by rise in temperature, and by some degree of *malaise*. By watchfulness on these points, therefore, we may often stave off an attack, or may prevent its passing from under our control. Many of these seizures, also, are toxic in their nature ; and, under the pure-air treatment, their occurrence is rendered less likely. It is remarkable how seldom any of those who pass their days in the open air fall victims to catarrh.

It must not be forgotten, however, that in the lungs of most consumptives there is an abundance of organisms, many of them of a septic character, which lie in wait for a suitable opportunity for attacking the system when it is at its weakest. Nothing gives so favourable an opening to these micro-organisms as a sudden chill or an unequal exposure of the body to cold. It depresses the vital powers, and gives a nervous shock, such as will often precipitate an attack upon the weakest portion of the frame. It is on this account that it is so important to guard our patients from unequal draughts of cold air ; and, though one cannot but look with interest upon the experiments in hardihood which are being made in some sanatoria, it is also with much misgiving, and, for my own part, I would rather take the experience of Drs. Brehmer and Dettweiler as my guide. It is not necessary to say anything here as to the treatment of an attack of inflammation ; but we shall do well not to neglect some of the traditions of our predecessors.

Suitable amusement.—This is not the least important of the requirements. If the family are

willing to help efficiently this can be carried out even better at home than in a sanatorium. Most forms of *al fresco* entertainments are admissible; always provided that the patient does not become excited, increase the rate of breathing, or get overtired.

Conclusion.—In conclusion, I would repeat that it is impossible to carry out all the stringent conditions of successful 'pure-air' treatment without the constant supervision of a medical man and the services of a well-trained nurse, or an intelligent and trustworthy attendant specially detailed for the purpose; but I venture to submit that none of the conditions which have been mentioned are unattainable except in the homes of the very poor, and for these persons suitable asylums should be provided at the public expense.

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